

Osborne Wight
1781

THE ELECTRICAL PHILOSOPHER,

CONTAINING

A New System of Physics founded upon the Principle of an *universal Plenum* of *elementary Fire*, wherein the nature of elementary Fire is explain'd, its Office pointed out, its extensive Influence and Utility in explaining many of the most abstruse Phenomena of Nature shewn, and the *Grand Desideratum* in particular which has been hitherto either entirely given up as inexplicable, or else sought after in vain by the most able Naturalists, is at length happily obtain'd, viz. the *Cause* of Gravity, the *Cause* of Cohesion, &c. &c.

The greater part of the Publication is disposed in the form of a Dialogue, as the most familiar method of conveying Instruction, and the whole is offer'd to the Public by way of Supplement to the Philosophical Essays lately published by the same Author.

To which is subjoin'd a

P O S T C R I P T.

Containing Strictures upon the *uncandid Animadversions* of the Monthly Reviewers on those Essays.

K

By R. LOVETT, LAY-CLERK,
Of the *Cathedral Church* of WORCESTER.

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TO THE
RIGHT REVEREND FATHER IN GOD

JAMES, LORD BISHOP

W O R C E S T E R

NATURAL PHILOSOPHY

UPON A FIRMER AND MORE EASY

THAN THAT ON WHICH IT IS USUALLY



INSCRIBED BY THE

most obliged and

RICHARD B. GAYLOR



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THIS ATTEMPT TO PROMOTE USEFUL KNOWLEDGE,
BY ESTABLISHING
NATURAL PHILOSOPHY
UPON A FIRMER AND MORE RATIONAL BASIS
THAN THAT ON WHICH IT IS FOUNDED AT PRESENT,

Is, with the greatest

Respect and Veneration,

Inscribed, by his LORDSHIP'S

most obliged and obedient

humble Servant,

RICHARD LOVETT.

READER

*** I THOUGHT AS I WROTE THIS
 A * Nature and spirit of the elec-
 *** tual fluid was really claim the A.D.
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TO THE
READER,

ALTHOUGH an Enquiry into the
A Nature and important Uses of the elec-
trical Fluid may justly claim the Abi-
lities and Address of a first rate Wri-
ter, yet since no such has appeared willing to
undertake it, I cannot help thinking *myself*
under some obligation to engage in it, so far at
least as may be thought consistent with a Sup-
plement to my former Writings on that sub-
ject; in which I had always in view, *that*
which seems to have been too studiously avoid-
ed by others, viz. the Uses which such an
amazing Instrument of Nature was ordained to
serve in the Creation; which Uses are doubtless
adequate to the greatness and extensiveness
of its Power.

That so few Enquiries have been made con-
cerning its Nature and Uses, seems the more
unaccountable, since myriads of Experiments
have been made, all of which invite, as it were,
our researches into so curious a subject. —

Can any thing then but an invincible prejudice
in favour of preconceived Opinions be imagin'd
to be the *cause* of such a reluctance to the
investigating of an object so promising and so
interesting as elementary Fire appears to be? (a)

(a) I call this Fire elementary from its great purity and
universality, and its appearing in form of Air.

How assiduous were Philosophers, particularly Mr. Boyle, in cultivating and improving the *Pneumatic Engine*; and with what unwearied diligence did he pursue the Experiments made therewith, although the most he could propose from them was the enquiring into the Nature and Properties of the *common Air*. How much more then might be reasonably expected when by means of the *Electrical Engine* we had discover'd the pure, primary, elementary Air or *Æther*? Was it not reasonable to think that Philosophers would have exulted at the Discovery, and doubled their diligence in their Enquiries into the Nature of a Principle which they always before imagined had no existence?—— But instead of availing themselves of a *light* which unexpectedly appeared in order to conduct them to Truth, they seem to have sitten supinely for near thirty Years after the Discovery, as if nothing had happen'd worthy their notice. Such thoughts brought to my mind an Observation of the Rev. Mr. Jones's, viz. "Electricity, which has given to this Age an Advantage over all that went before it, and should have open'd to us a new world of Philosophy, has left us just where it found us," and there we must necessarily remain till we can prevail with ourselves to cultivate and improve the Discoveries already made, and begin the search of Nature afresh.—— I would not be understood by this to abandon Sir *Isaac Newton*, but so far from it,

TO THE READER. iii

it, that I am thoroughly convinced, all attempts will prove vain and fruitless, if we do not proceed upon his Principles.

Unless we pursue the Discoveries which Sir *Isaac* has already made, it will be absolutely impossible to understand the nature of the *electrical Fluid*, so as to explain, in a satisfactory manner, even the very Experiments which we are most familiar with. — What I mean by the Discoveries that Sir *Isaac* has already made, is, First, the inherent or natural Properties of *Aether*, viz. its indefinite elasticity and rarity, and, Secondly, its existence in the pores of all gross bodies. If these things be not strictly attended to, it will be in vain to attempt the explanation either of the newly discover'd *Fire*, or of the Experiments made with it.

Such Assertions may probably be censur'd as the effects of crude and precipitate Reflexions; but I can with great Truth affirm they are so far from *hasty* thoughts, that they have been cultivated with the strictest and most deliberate attention, and I am therefore very certain that the Experiments are not explicable on any other Principles whatever. — Surely the candid and judicious will not censure and condemn me for affirming so peremptorily, that which I am thoroughly convinced of from a crowd of unbiass'd witnesses: Or in other words, if the Experiments be ever so much diversified, they are sure to strengthen and confirm each other, when examined on the afore-

said plan, viz. that of such an indefinite elasticity and rarity.

That so interesting a Discovery has lain so long uncultivated by others, seems the more remarkable, when we reflect on the jealousies that have subsisted among Men, when all, that has been contended for, was perhaps a little empty honour of being the first Inventor of a Rule or Method for solving particular geometrical Problems (a): Or being the Author of some new Discovery in Astronomy (b).

(a) How great the contention was between the English and French Geometicians concerning the Invention of Fluxions, is well known: The former maintaining that Sir Isaac Newton was the first Inventor of them; the latter, that they were invented by Mr. Leibnitz?

(b) Dr. Delagalliers after mentioning Dr. Bradley's method of finding the annual Parallax of the bright Star in the head of Draco, adds, "So that now the motion of the Earth is settled by astronomical Observation. This Discovery of so great Consequence to Astronomy, which has been attempted in vain for many ages, and at last made in the Year 1728 is yet mention'd no where that I know of, but in the *Philosophical Transactions*. Had this been found out by some Foreigners, we should have had whole Volumes written about it in a pompous manner before this time. It is surprising that in the term of five years since the Publication of it, none of the learned Gentlemen abroad have taken any notice of it, either to object against, or acquiesce in it."

"This shews us," he says, "that the Parallax of the fixed Stars is much smaller than has hitherto been supposed by those who have pretended to deduce it from their Observations; for instead of many seconds it does not amount to one: Hence it follows that the above-mentioned Star is above 400000 times farther from us than the Sun." See Dr. Delagalliers on Experimental Philosophy, Vol. I. page 386.

TO THE READER.

To find out the true nature and inherent or essential properties of the electric matter, has, I may truly say, been the principal or rather the sole object of my attention and study, almost ever since the great force of the Leyden Phial was discover'd, in order to enquire into the difference of the nature of the electrical fluid and common matter; the former of which is found to be endued with real activity, whilst the latter remains entirely passive and inert.

As Sir *Isaac Newton* was the only one among modern Philosophers, who had studied the nature of such a subtle Medium so far as to investigate the laws by which it was govern'd, I happily consult'd his Writings concerning it; happily I say, having since discover'd it to be the only successful method I could have taken; for to him alone we are indebted for that which is since found to be the only guiding clue to the most important Discoveries, that is, to those inherent properties of indefinitely great elasticity and rarity of the subtle Fluid above-mentioned, of which we have, by means of electrical Experiments, made a most complete Discovery.

To him also and to him only, are we indebted for pointing out its existence in the pores of all gross bodies: For the investigation of the former, See his *Optics*, *Quere. 21.* or the beginning of *Chap. V.* page 67 of my *Essays*; and of the latter, See the concluding Paragraph of his *Principia*, or my *Essays*, p. 36. sect. 75.

Q.T.

Had

vi TO THE READER.

Had it not been for these important Discoveries of Sir Isaac, electrical Philosophers as well as all others, had been intirely destitute of a rational Method to explain any of the electrical Experiments, so as to render them reconcilable with one another, whereas by means of the foremention'd Assistance they are enabled, as with a Key, to unlock many of the greatest difficulties, relating to electrical Experiments, which, as before observed, it would be in vain to attempt on any other plan; and such vain attempts I am fully perswaded are the only Reasons why the electrical Fluid seems still given up as inexplicable, and indeed ever since the first Discovery of that wonderful Power of Nature, the *elementary Fire*, I have shewn a great propensity to enquire into its Nature, Office, and the Uses it was ordained to serve in the mundane System, as others have a reluctance to such an enquiry.

I must further inform the Reader that altho' the principal part of this Supplement is intended to consist of Dialogues, yet, as some portions of it could not properly be digested into a colloquial Form, the whole is to be consider'd as a Miscellany of Dialogues, Quotations, Recapitulations, &c. And I flatter myself such an indulgence will be readily granted me when it is considered that I am the only one who has attempted to make a minute Enquiry into the Nature and Office of this universal Fire, and who am consequently destitute of the common

Pri-

TO THE READER vii

Privilege of other Authors, viz. that of consulting the Writings of those who have gone before them on the same Subject.

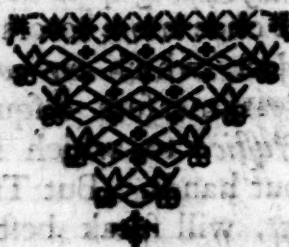
But after every Indulgence I can hope for from the Public, I shall think it ever incumbent upon me to make the same Confession which my Heart dictated to my Pen when I was engaged in the publication of my Essays, viz. "That sensible of my deficiency, I think it my duty to apologize for an attempt of this nature rather than to plead any thing for the merit of the Work." However, fired with a Love of Truth, and animated by the Candor and Encouragement of the most respectable and discerning part of my Readers, I have ventured once more to crave their attention to a Subject, which my want of *Literature* in a great measure disqualifies me from doing that *Justice* to, which it deserves and demands at our hands. But Truth, evidenced by *Experiment*, will speak best for itself, and needeth not those Embellishments and Flowers of diction by which alone *Hypothesis* are generally supported: And I flatter myself that the time cannot be very distant in this illuminated Age, when that *truly natural and rational Philosophy*, which Electricity has pointed out to us, will be universally adopted and approved.

N. B. I cannot help remarking here in brief, that my Endeavours to elucidate this Subject, have met with some Opposition; but whether my Researches ought to be discounte-

nanced

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nanced or encouraged, I shall leave to the judicious to determine, requesting only of them, an attentive and candid perusal of the following Pages.



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Tappets, Thomas, Esq; Dursley Gloucestershire

Terret, Mr. John, Apothecary, Tewkesbury ditto

Turner, Mr. Thomas, Worcester

U.

Urwick, Rev. Mr. Thomas, Worcester

W.

Wanley, Rev. Dr. *Rector* Elmley-Lover *Worcestershire*

Wilmot, Rev. Mr. Beverley ditto

Waldron, Rev. Mr. *Rector* Hampton-Lover ditto

Willes, Rev. Mr.

Wesley, Rev. Mr. John, London

Withers, Charles Trubshaw, Esq; Worcester

Wall, John, M. D. ditto

Wall, John, M. D. Gloucester

Witherings, William, M. D. Stafford

Wingfield, George, Esq; Worcester

Walsh, John, Esq; M. P. for the City of Worcester

Wrenford, Thomas, Esq; Kempsey *Worcestershire*

Wilkins, Mr. Nathaniel, Worcester

Wilkins, Mr. Stephen, junior ditto

Watkins, Mr. Gregory, Attorney, Kidderminster

Watkins, Mr. Thomas, Attorney, Worcester

Wood, Mr. James, Gloucester

Wheeler, Mr. Thomas, Bromsgrove *Worcestershire*

White, Mr. James, Norton

ditto

Willoughby, Mr. Thomas, Worcester

Wagstaffe, Mr. John, Norwich

Wagstaffe, Mr. Thomas, Yarmouth

Wickins, Mr. Thomas, Worcester

Y.

Young, Rev. Mr. Prebendary Worcester Cathedral

Yeates, Robert, Gorges Dobyn, Esq; Gloucestershire

Yeates, Mr. Henry Gorges Dobyn, ditto

Young, Mr. George, Land-surveyor, Worcester



INTRODUCTION.

MY Philosophical Essays having been seven Years published, and notwithstanding they have been stigmatiz'd as heterodox, yet, as they have never been answer'd by way of serious Refutation, but on the contrary, honour'd with Encomiums by various eminent Authors, amongst whom were some of the most profess'd and judicious Critics of the present Age, (a) I am encouraged to hope that they have been look'd upon as founded on rational Principles, notwithstanding their variation from receiv'd opinions: I shall however flatter myself that I have sufficient reason to think so, until such principles be disprov'd and set aside by more convincing arguments, and supported by Experiments equally conclusive.

Since therefore they have been well receiv'd by many, and the perusal of them recommended by impartial and learned Men, I am excited to put Pen to Paper again on the same Subject, more especially as Experience and Ob-

(a) The Authors of the *Critical Review* were so candid as not only to give a brief account of some of the principal parts of the Essays, but to conclude with a commendatory Character of them — See *Critical Review* for October 1766.

B

ser-

INTRODUCTION.

servation have since furnish'd me with a variety of other useful Discoveries, which enable me to illustrate and confirm what I before advanced.

What I have more to offer is therefore intended as a Supplement to those Essays.

Being in company with a facetious speculative Gentleman, and the conversation happening to turn on Electricity, he declar'd that the Electrical Phenomenon seem'd so surprizingly abstruse and mysterious, as in his opinion never to be rationally accounted for on any natural principles whatever, so as to be render'd intelligible.

I told him I was far from thinking so, and that the rendering of it so plain as to be easily understood was the principal, or rather the only Reason why I undertook to write my Philosophical Essays; and that I could not help thinking I had so far succeeded in the Attempt, that little could be found wanted in them to render the Electrical Appearances and their causes perfectly intelligible, particularly if they were perus'd attentively, and impartially examined with that view.

N. B. I shall proceed in the present enquiry as if still confabulating with the same Gentleman, by way of a familiar Dialogue between *A* and *B*.

Dialogue



DIALOGUE. I.

FIRE, a permanent Principle.—HEAT, not an essential Property of FIRE.—The PORES of WATER replete with FIRE.—QUICKSILVER frozen.

B. Y early visit, Sir, this Morning is occasioned by what I have heard since our last Conversation.

I was mentioning in a select Company what you advanced relating to Electricity, and they seem'd to censure you, or rather to set you at nought, for these three Reasons: *First*, as an Innovator, that maintained heterodox Principles. *Secondly*, that you are too precipitant in your Application of the electrical Fluid, before a sufficient number of Experiments had been made to confirm such reasoning. *Thirdly*, that you expressly asserted, that there was no Heat in Fire.

A. As for their *first* Reason, that of censuring me for maintaining Principles different from the generality of Mankind; 'tis presum'd I may

appeal to all judicious and candid Men, whether it be a just Reason for Censure, if others have not made the same Enquiry into those things about which we differ. — Their *Second* Reason, that of being too forward in my Enquiry as to the Nature and Uses of the electrical Fluid, before a sufficient number of Experiments had been made by way of examination into the nature of it, I am at a loss to know, since Myriads of Experiments have been already made, and more are daily making.

Besides I can assure them that such a multiplicity of Experiments are not absolutely necessary; a few well chosen ones will be found to be abundantly sufficient. — Nor can they say that a sufficient length of time to make a fair Trial has been wanted; Experiments having been made with it considerably more than fifty Years since modern improvements; — *First*, by Mr. Hauksbee; next by Mr. Stephen Grey of the Charter House; with Mr. Du Faye, and others.

As to their last Reason it will be necessary for me, in order to wipe off such an Opprobrium from my Book, to inform the heedless and injudicious Reader, (for no other I may well suppose could mistake my meaning) that altho' it asserts that Heat is not essential to Fire, and produces a variety of Instances to prove that in many cases Fire shews no signs of Heat, yet at the same time it
main-

maintains that the greatest Heat of all is the effect of Fire only, and shews by what means it was produced; (a) therefore to prevent Errors of the same kind for the future, I am inclined to think it necessary for me to recapitulate some of those parts of the Essays which relate more particularly to that Subject, especially the Definition of Fire and Heat, and the Observation on cold Fire. — *First* then,

“ *Fire is an Element in the strictest Sense of the word, and is consequently a permanent Principle.*”

“ *Secondly, That it is in form of an exceedingly fine Air or Æther, and is by means of Electricity discover'd to exist in the pores of all gross Bodies with which we are conversant.*”

“ *Thirdly, True Fire subsists without a Pabulum, and consequently yields neither Smoke, Ashes, nor any other gross feculent Matter.*”

Which remarkable Purity we looked upon to be peculiar to the Solar Fire when collected in the Focus of a Burning Glass, or a concave Speculum, till the Electrical Apparatus opened another to our view, which appears to be equally pure with the Solar, and which may therefore be reasonably supposed to be strictly one and the same.

(a) Witness Villettes's Mirrour.

“ *Fourth-*

“ Fourthly, *True Fire is either hot or cold,*
 “ (a) *according to the temperature of the Body*
 “ *in which it exists.*”

“ To these might be added those essential
 “ Properties of indefinite Elasticity and Rarity,
 “ since these are so absolutely necessary, that
 “ without them there wou’d be no such thing
 “ as explaining any of the Experiments in a
 “ rational and satisfactory manner.”

“ The Author thought a positive Definition
 “ of Fire to be necessary, since Elementary
 “ Fire is a term frequently met with, but
 “ yet not always understood, even by those
 “ who make use of it; and is therefore often
 “ taken in a vague sense and in different

(a) “ Here I expect, as I have formerly remark’d, to meet
 “ with the same fate which most others have done, who
 “ with an honest opposition to rooted prejudices have dared
 “ to advance paradoxical Truths.”

“ Amongst the various methods adopted by shallow
 “ Minds for the deciding of Controversies, there is none
 “ more frequently made use of by them than what is com-
 “ monly term’d the HORSE-LAUGH. This, like an impetuous
 “ torrent, carries all before it: No remonstrance of Reason;
 “ no strength of Argument can obtain the least hearing in
 “ the tumultuous uproar; nor shall I at all wonder if I
 “ experience the like treatment myself from the unthinking
 “ and prepossess’d Multitude, in whose injudicious and
 “ unphilosophical Ears, cold Fire may sound as the highest
 “ absurdity, a contradiction in very terms. But the Appro-
 “ bation of such incompetent judges is what I am not so
 “ ambitious of, as to offer an oblation, precious as Truth,
 “ at the Altars which their Fancies have erected. To my
 “ inquisitive, discerning, and unbiass’d Readers I address
 “ my Diquisitions on this intricate Subject, well knowing
 “ that they will examine with Temper, and decree with
 “ Justice.”

“ mean-

“ meanings; I have therefore confined it to
 “ that particular and restrained Sense which
 “ only it properly bears; no Fire having a
 “ right to the epithet pure, but that which
 “ subsists as above remarked, without a
 “ Pabulum; nor did we know of any
 “ Fire that had the least pretension to
 “ such a Purity besides the Solar, till we
 “ were agreeably convinced to the contrary
 “ by the Discovery of the Electrical Fire.”



ON HEAT and MOTION.

HEAT is an accidental Property or Quality of Fire generated at pleasure by the mutual Attrition of the Particles of the Fire; or in other words, when Heat is produc'd by the Attrition of two Bodies, the strict and proper cause of such Heat is the mutual Attrition of the Particles of the Fire contained in those Bodies, consequently Heat is the effect of that mutual Attrition.

Hence Heat is generated, increased, and continued in proportion to the violence and continuance of that mutual Attrition of the Particles of the Fire; and we shall have sufficient Reason to believe (when we come to shew the method by which the greatest Heat

was

was produced that ever has been known) that if it were possible to divest any two Bodies of the Fire contained in their pores or interstices, no Heat at all would be produced by the friction, tho' ever so violently and ever so long continued.

Hence also, though the vulgar expression *hot as Fire* implies that Heat is the very Essence of it, yet if we do but reflect on the Effects of the foregoing Experiments, we shall behold a cloud of Witnesses all of them ready to testify, *that Heat is not an essential Property of Fire; for Fire is not always hot*, even when capable of melting Metals, if effected by Electricity.— Dr. Franklin melted brass Pins, and steel Needles, Gold, and Glass. “And though” says he “I have taken
“ up the pieces of Glass between my Fingers
“ immediately after this melting; I never
“ cou'd perceive the least warmth in them.”
Dr. Franklin's Letters, Edit. 2d. p. 66.

Again, Tho' Water is naturally cold, yet we find the pores of no one thing more plentifully stored with Fire than those of Water; nor is there any thing besides Metals, from which pure Fire can be so plentifully obtain'd. Since then it always exists in Water while in a Fluid form, who can doubt the truth of the Assertion of the great Experimentalist Dr. Boerhaave, viz. “that an incredible Quantity
“ of Fire is contain'd in the coldest masses
“ of Ice, and may be instantly produced from
“ them

“ them with a great deal of Violence?” (a)

But although it seems true from the Premises, that Fire is frequently *COLD*; yet that can be only in a limited Sense, since Bodies are only comparatively *cold* or *hot*.

That which is greater than the heat of the human Body we term *hot*, and that which is less, we term *cold*, though in a more unlimited Sense Fire may not improperly be said to be always possessed of heat and motion too in some degree.

To render myself on this head the more plain and intelligible, I must transcribe another passage from the abovemention'd celebrated Author on Heat and Motion, tho' to say the truth, he confounds the terms Heat and Fire.

“ There is still another *motion*,” says he, “ which I ascribe to Fire, which is the constant effect of its proper agility; and this is most evidently demonstrated by undeniable Observations. Let us, for instance, consider Water when it is 33 degrees cold, and it will then be in its coldest State; that is, it will contain as small a portion of Fire, as in the nature of Things can possibly reside in pure Water; for if this simple Water be effected with a greater degree of Cold, it will not continue Water any longer, but be converted into a pellucid brittle Substance

(a) Boerhaave's Elements of Chymistry, Dallow's Translation, Page 81.

“ called Ice, tho’ reducible again to Water
“ by a heat of 33 Degrees. Hence therefore
“ it appears evident, that Water is Water
“ only by the Motion of the Fire residing in
“ it, and that it is not Water from its own
“ Nature consider’d separately and alone: The
“ same is true of Glafs, Fossils, Sulphurs,
“ Semi-Metals, Metals, and perhaps of all
“ other Bodies, which appear in a consistent
“ form in a smaller degree of Heat, but are
“ put in fusion and converted into a kind of
“ Water if the same is increased to a certain
“ degree, which will be different, according
“ to the various Natures of the Substance
“ under Examination. Since therefore by
“ Fahrenheit’s Thermometer the natural Heat
“ has been observ’d 33 degrees below the
“ freezing Point, hence we see evidently, that
“ thro’ all the difference of 33 degrees the
“ Fire was agitated with a motion that grew
“ gradually less and less, but was never totally
“ destroy’d; and therefore even at that Time,
“ when all Animals and Vegetables perished
“ thro’ the excess of the cold, the Fire was
“ not absolutely at rest. Therefore we may
“ safely assert, that the Fire was even then in
“ motion. But as it appears from Experi-
“ ments, that this Fire may be diminish’d
“ artificially still 40 degrees more, we are
“ hence certain, that Fire, in the greatest
“ natural cold possible, is agitated 40 degrees
“ more than it is in this artificial one, and
“ that

“ that again thro’ every intermediate degree it
 “ is continually dissolving some Bodies, which
 “ a little after in a smaller degree of Heat,
 “ appear of a solid Consistence. Fire, there-
 “ fore, is perpetually agitated in the greatest
 “ Cold, and still gradually more and more in
 “ every increase of Heat; and consequently is
 “ always hot and in motion.” See my Essays,
 Page 248. Section 160.

“ N. B. There is another fluid Substance
 not yet taken much notice of, which re-
 quires the greatest degree of cold of all
 others to convert it into a solid, namely,
 that of Quicksilver; which is of late Years
 found to become so by means of a certain
 degree of cold, as well as Water and many
 other Things. ——— ¶ See, *an Account*
of artificial cold produced at the Royal Aca-
demy of Sciences at Petersburgh, by Doctor
Himself. In a Letter to Doctor De Castro,
F. R. S. Translated from the French by James
Parsons, M. D. F. R. S. from the Philoso-
phical Transactions”.

“ This Effect was produced by means of a
 freezing mixture by which Fahrenheit’s
 Thermometer was reduced $65\frac{1}{2}$ degrees
 lower than the 40 degrees before mention’d,
 the sum of which is $105\frac{1}{2}$ — or to speak
 more intelligibly, if Fahrenheit’s Thermometer
 is at $105\frac{1}{2}$ degrees when the Mercury
 begins to freeze, and at 33 when the Water
 begins to freeze, consequently the Motion and

Heat of the Fire contain'd in each will be as those numbers, that is, the smallest degree of motion and heat, which is just sufficient to melt the solid Quicksilver, and the increas'd motion and heat, which is just sufficient to melt the solid Water, are as the number $105\frac{1}{2}$ and the number 33".

" From such a method of Reasoning, we may conceive all the different degrees of Motion and Heat in agitated Fire, from the least to the greatest, that is, from the smallest degree of the motion and heat of Fire which melts the solid Quicksilver, even to the greatest imaginable, namely, that surprising degree of motion and heat which is produced at the Focus of Villette's Mirrour".

" N. B. This must be a more intelligible way of arguing, than that of *Heat* and *Cold*; for as it is allowed that Heat is only relative, that is, the Heat which is less than that of the human Body, we term *cold*, and that which exceeds such Heat, we call *hot*; Heat and Cold therefore cannot be so just a distinction, as to term them different degrees of *Heat*; because it is not a little difficult to know where to place the Zero (or 0) on the Thermometer, to point out where the Cold begins. If this Distinction be disliked on account of the manner of defining it, the World will be much indebted to any one, who can shew where to fix the standard on the Thermometer that will shew where the Cold ends, and the

the Heat begins. — Hence appears the necessity of making choice of the most adequate Terms”.

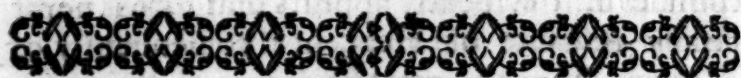
The foregoing Observations being duly consider'd, it evidently appears that Fire is never totally destitute of Heat, nor consequently of Motion, from the greatest degree to the least : And if we use the same Author's Term, Cold instead of less degree of Heat, then we may say, that Fire in the greatest artificial *Cold*, that is possible, is agitated 65 degrees and an half more than it is in the foremention'd artificial one of 40 degrees, i. e. $105\frac{1}{2}$, from which greatest degree of Cold, through every intermediate degree, it is continually dissolving some Bodies which a little before in a smaller degree of Heat appear'd of a solid Consistence. Fire therefore is perpetually agitated in the greatest Cold, and still gradually more and more in every increase of Heat, and consequently is always hot and in motion.

By the help of this Recapitulation I hope I have so fully declar'd my Sentiments on Fire, and the cause of Heat, that no one will have the least room to think that I ever was so inconsistent with myself, as even to insinuate that I suppos'd there was no Heat in Fire.

„ The Analogy or degree of proportion between the Elasticity and Rarity of the common Air, and the same Properties in *Æther*, was according to Sir *Isaac Newton* as 700000 to 1.

It

(a) It was this remarkable Difference of those inherent Properties, which was the cause of my making a more peculiarly strict scrutiny into it, than I shou'd otherwise have done".



DIALOGUE II.

*Electrical Fluid, true and real Fire;
indefinitely elastic and rare; acts by
Pressure, or an impelling Force; the
Author charg'd with deifying it;
delegated by the wise Author of Nature.*

B.  H A T else is necessary to be known before the Experiments can be satisfactorily explain'd, and the electrical Fire render'd intelligible?

A. One thing more is altogether as necessary as the former, viz. that which Sir *Isaac* hinted at in the concluding Paragraph of his *Principia*, namely, "now we might add," he says, "something concerning a certain most subtile Spirit, which pervades and lies hid in all gross Bo-

(a) For Sir *Isaac's* Computation and the manner of Investigation, See his *Optics*, Quære 21st. or *Essays*, p. 68.

" dies, &c." which altho' but a mere hint, (*a*) was discover'd when examin'd by electrical Experiments to be just: Nothing is more clear and obvious, than that we obtain'd the same Spirit from the pores of all contiguous non-electric Bodies. But more of this hereafter.

These Discoveries of that great Philosopher, of the remarkable Rarity and Elasticity of *Æther* are absolutely necessary to be known, before the Experiments can be render'd intelligible, or even reconcileable to one another; (*b*.) which if duly attended to, will prove (as was observ'd in my Essays) a Key to solve and unlock most other Difficulties throughout all the Operations of Nature.

B. I must own that your Arguments seem so rational and persuasive, as to excite my Curiosity to become better acquainted with this amazing Power of Nature, since you assure me the thing is not so very difficult as I imagined, and particularly, if it be examin'd with attention and impartiality. In order therefore to do it the more effectually I will undertake the perusal of your Essays again; for altho' I read them once, I must confess I did not much consider the true purport of them, and as at the same time I thought the Subject too diffi-

(*a*) This I call a mere hint, because nothing relating to the same Subject occurs in all his *Principia*, but in that portentous Paragraph only with which he concludes.

(*b*) This has been thoroughly consider'd by electrical Philosophers.

cult ever to be understood, probably that was the reason of my Reading them over too cursorily.

A. Before you begin the Book again, it will be necessary to inform you, that the electrical Fluid is in form of an extremely elastic Air, and, as you will find, indubitably prov'd to be true and real Fire, and withal, as pure as the solar Fire in the Focus of a burning Glass, since like that it yields neither Smoke, Ashes, nor any other gross Matter.

And here I must previously observe to you, that this is what the Ancients and some few of the more discerning Moderns have term'd elementary Fire; how they discover'd that such a Principle existed, and particularly that it was Fire is not easy to conceive; and notwithstanding this their Description of it was just what we find it to be, since we have made so complete a Discovery of it, as even to realize it to the Senses.—You will likewise find that it appears to be an universal Agent in the strictest Sense, so as to occupy and fill all Space, not only all free and open Spaces, but the *minutest vacuities and interstices or pores of the most compact and solid Bodies*, agreeable to the Prediction of Sir *Isaac Newton* as we find it in the concluding Paragraph of his *Principia*, as hinted above, and as will more fully appear from Experiments in various parts of the Essays, particularly at Pages 37. 38. 39. and 40. &c.

B.

B. What do you really believe might be safely concluded concerning its Nature, Office, and general Use?

A. Were I to declare my own private Sentiments to you, I shou'd affirm, without any hesitation, that this grand Principle is the primary or first, and indeed, sole Cause of all other secondary Causes whatsoever.—That it is indefinitely elastic, and acts by pressure or an impelling force; the mechanical Cause that we breathe, live, and move; the efficient Cause of all motion; the physical Cause of Gravitation, Cohesion, Magnetism, the ebbing and flowing of the Sea, and of all other the most abstruse Phenomena of Nature.

B. Why, my Friend, you take most ample strides indeed! I am afraid Electricity has turn'd your Head; since you go on thus, I must look upon you as a down right Enthusiast, and that you are electrically mad.

A. You may, Sir, rally and banter me as you please, and think that I have taken unwarrantable steps; but I am persuaded you will find that I am not the only Person who has affirm'd very great things of this universal powerful Principle, which Electricity has discover'd to us. As first, Dr. *Franklin* has undeniably prov'd by his Experiments, that the electrical Fluid and the Fire of Lightning are indubitably the same, affirming that the greatest known Effects of Lightning may be exceeded by it. Secondly, we are inform'd by the learned

D

Dr.

Dr. *Priestly*, in his History of Electricity, that it is the general opinion of the most learned Electricians, that the Aurora Borealis, falling Stars, all Meteors in the Air, Water-Spouts &c. at Sea, Whirlwinds and Hurricanes by Land and even Earthquakes are electrical Phenomena: This is the clear opinion of Dr. *Stukely*, whose ingenious Papers on the same Subject were read and approved by the Royal Society (a). The most judicious and justly admired Author the Rev. Mr. *Jones*, another ingenious Electrician, after speaking of Electricity, proceeds yet farther, and affirms there is hardly a motion in nature which this “ Fluid, when applied by a diligent Experimentalist, is not capable of producing.—
 “ It will give a rectilinear motion in all directions; will produce the motions of Rotation and Revolution; it will keep a Body suspended at a certain distance in the Air without any visible cause, and make it turn swiftly on its Axis; it accelerates Vegetation, increases the motion of Blood in the Arteries, raises Water into Tides, and, in a word, will shew itself as a natural Instrument to be little less than *All-Sufficient* (a).”

B. *All-Sufficient!* Why then I find Electricians dont stick at *deifying* it; since you affirm it so Universal as to be present in all places,

(a) See Dr. Priestly's History of Electricity, p. 381.

(b) Rev. Mr. Jones on the first Principles of Natural Philosophy, p. 26. or in the Essays, p. 402.

and in the pores of all Bodies, which is affirming it to be *Omnipresent*, and if this be not deifying it, I am at a loss to know what is so.

A. Whatever you may think, I have affirm'd no more concerning its Universality, Nature, Office, and several Uses, than what appears not only probable, but what has been confirm'd by undeniable Evidence and actual Experience, as all sincere unprejudiced Enquirers after Truth, who are conversant with electrical Experiments, are thoroughly convinced of; for which, and other like reasons, it is my humble opinion that it ought to be esteemed as *sacred*, i. e. delegated by the wise Author of Nature to be the principal, if not the only instrument which he has appointed and makes use of to execute his Divine Will throughout the mundane System. I am therefore so far from retracting what I have affirm'd of it, that I am fully convinced I do not overrate its Excellence in calling it an universal, mechanical Instrument of Nature; nor will you find when you read over my Essays with attention, that I have exaggerated or gone beyond what is there prov'd by the most convincing Experiments.

B. I think you are rather positive in your assertions, but as you aver that they are founded upon the most unexceptionable Experiments, I shall think myself greatly obliged to you for your further observations on this important subject.

A. If you will only hear me with Impartiality and Attention, I am persuaded I shall be able to make you a Convert to Truth.



DIALOGUE. III.

The Necessity of Recapitulation. — An Investigation of the extreme Elasticity and Rarity of Æther. — Contradictory Principles of the current Philosophy. — Necessity of explaining Terms. — Gravity and Attraction made use of in one and the same Sense.

A.  Have had many thoughts concerning our last Conversation, and don't much wonder that you, who have not been conversant with electrical Experiments, shou'd think me sanguine and positive in my Assertions, but cannot help admiring at the same time that amongst so many learned Electricians, and such as profess themselves Newtonians, few, if any, have applied the subtile Medium to the Explication of the Phenomena of Nature.

Sir

—Sir *Isaac Newton* was of opinion, that a subtile Medium not only existed, but also that *it was the Physical Cause of all the capital Phenomena in the universe*: Whereas we, that have made a great Discovery of it, seem to look upon the Sentiments of so great a Man, as unworthy our cultivation and attention. And, even you yourself, had you read my *Essays* with care, might have been able to judge for yourself of these Matters. — There you wou'd have seen how cautious I was, and the care I took that I might impose neither on myself nor others.

When I first began my enquiries, finding that Air was a principal Agent in producing such wonderful effects in Electricity, I was led to enquire more particularly into the Nature, Properties and constituent Parts of the Atmosphere, accordingly I consulted the most authentic Writers on that subject, and particularly the learned Bishop Berkeley, who had bestow'd much time and pains on it, and adopted many of the Opinions of the Ancients concerning Air (a). After pursuing such enquiries, I discover'd that the electrical Fire itself was only a more pure and exquisitely elastic Air: I was therefore convinced that I could not fix my First Principles on any Basis so firm as on Air, which are, as you will find, in *Essays*, Page 22. Sect. 50.

(a) *Essays*, Page 9. Section 31.

From p. 33. to p. 37. are Lord Bacon's and Sir Isaac Newton's Sentiments concerning a subtile *Æther* or Spirit in the pores of Bodies: From thence to Page 40. Section 83. are Experiments to prove the same, and to shew by what means it is retained there.

Page 41. Section 85. shews how it was condens'd and retain'd in open Air.

Page 54. Section 116. shews that the particles of elastic Fluids mutually repel and recede from each other, prov'd by various Experiments.

Page 67. Section 141. Sir Isaac Newton's investigation of a method to prove the extreme Elasticity and Rarity of his subtile Medium or *Æther*, with a variety of others.

B. This method of Instruction might be very good, if my Head, like a common Place-book, could retain every thing that was committed to it, but as that is not the case, I must beg you to be somewhat more explicit, and make Recapitulations wherever they may seem most requisite, otherwise a great part of your trouble will be thrown away; that is, if you don't repeat the whole Passage where such Repetitions are necessary.

A. I cannot but own that your observation is just, and that mere references might not be always sufficient; I will therefore, according to your desire, be more particular, especially as you seem determined to pursue the Subject in good earnest. Besides should I ever have a
mind

mind to publish this Conference, those Readers who have never seen the Essays, will be as well pleas'd with the Quotations as you; And though some might censure them as superfluous, they may easily pass over them; and I am convinced that in a Performance of this kind such Repetitions cannot well be avoided, except we choose to sacrifice perspicuity to conciseness.

B. I must now beg you to inform me what are the most essential Properties of this subtile elastic Medium?

A. An almost inconceivably great Elasticity, and yet as extreme a Rarity or Fineness as before mention'd. However, it must be owned, that we are highly indebted to Sir Isaac Newton for pointing them out. For had it not been for his assistance, we might have been still, and probably a much longer time, groping as it were in the dark after them, and perhaps never have been able to answer that Question satisfactorily.

When describing his subtile Medium or *Æther*, he informs us, that it is 700000 times more elastic than the Air and above 700000 times more rare. Query 21st. — But although such a subtile Medium, as Sir Isaac then conjectur'd to exist, is now actually discover'd by the clearest Experiments, and even realiz'd to the Senses, and which we find to be possess'd of those remarkable Properties which are above mentioned in a surprising degree; yet, we were

not

not aware, nor could ever have imagin'd, that the proportion of those natural properties or qualities in the *Æther*, and the same properties in common Air was so great as 700000 to 1, had we not been thoroughly convinc'd by Experiment of its extremely great Elasticity and Rarity.

In the next Query he says, if this *Æther* be suppos'd 700000 times more elastic, and above 700000 times more rare, its Resistance would be above 600000000 times less than that of Water, and so small a Resistance would scarce make any sensible alteration in the motion of the Planets in 10000 Years. — Here Sir Isaac seemed to doubt whether so great a Rarity wou'd be credited; therefore to obviate such an objection he seems to demand an answer to another Question, saying, if any one should ask how a Medium can be so rare, let him tell me how the Air in the upper parts of our Atmosphere, can be above a hundred thousand thousand times rarer than Gold?

Before the real discovery of such a subtile Medium by means of the electrical Apparatus, the very existence of any subtile Medium, besides that of common Air was denied and rejected with sovereign contempt, and is still disbelieved by very many, notwithstanding it is most clearly verified by Experiments even to our bodily Senses.

Hence the invisible power of Prejudice in favour of preconceived Opinions, insomuch as
to

to deny the plainest Facts. Those two inherent Properties appear in the electrical Fluid in a most wonderful degree, though the exact Proportion to the same Properties in common Air is not easy to ascertain: But by means of these two Properties in the electrical Æther, together with what was before hinted of its lying hid in all gross Bodies, the Experiments are solv'd in a rational manner, which would otherwise be absolutely impossible.

Of all the great Discoveries made by Sir Isaac Newton, those of the extreme elasticity and rarity of Æther will be found to be by no means the least, notwithstanding there hath hitherto been very little notice taken of them: However, I am confident they will be found absolutely necessary, before any considerable advances can be made towards explaining the Experiments. See the Investigation of those inherent properties, Optics, Query 21st. or in the Essays Page 68. Section 142.

But as neither of them may be ready at hand, I shall, for the information of my new Subscribers, repeat the Investigation, and the rather since some other things may by that means be rendered more clear.

First, That the Medium which propagates Sound is the common Air or Atmosphere; and that the Æther beyond the Atmosphere is the Medium which propagates Light from the Sun. He then considers the different Velocities of Light and Sound, and observes, *Secondly*, that

E

Sound

Sound moves no more than the space of 100 Miles in much about the same space of time that Light moves from the Sun to the Earth, which distance Sir Isaac computed at 70 Millions of Miles; so that the former is contain'd in the latter 700000 times (a). This datum slender as it may seem, was yet sufficient for his investigation of the proportion of that remarkable inequality, or difference, of the Elasticity and Rarity of the subtile elastic Medium or Æther, and the same qualities in the elastic Air (b); the following are his own words.

“ Sounds move about 1140 English Feet
 “ in a second minute of time; and in 7 or 8
 “ minutes of time, they move about 100
 “ English Miles. Light moves from the Sun
 “ to us in about 7 or 8 minutes of time, which
 “ is about 70,000000 English Miles; supposing
 “ the horizontal Parallax of the Sun to be
 “ about 12”, and the vibrations or pulses of
 “ this Medium, that they may cause the al-
 “ ternate fits of easy transmission and easy
 “ reflection, must be swifter, and by conse-
 “ quence above 700000 times swifter than
 “ Sounds, and therefore the elastic force of this
 “ Medium in proportion to its density, must
 “ be above 700000 multiplied by 700000 (c),
 “ that is, above 490000,000000 times greater

(a) As 100 : 1 :: 70,000000 : 700000; or
 as 700000 : 1 :: 70,000000 : 100.

(b) i. e. The Atmosphere.

(c) i. e. 1 : 700000 :: 700000 : 490000,000000.

“ than

" than the elastic force of the Air is in proportion to its density (a); for the velocity of the pulses of elastic Mediums are in sub-duplicate Ratio of the Elasticities and the Rarities of the Mediums taken together."

B. I don't understand Sir Isaac, since he makes use of the words Density and Rarity promiscuously, as if they were similar, notwithstanding they are opposite Terms.

A. If you consider the Purport of his Reasoning, you will find that the above mention'd density is so extremely small, that it is in reality, rarity; the greatness of the rarity and the smallness of the density being the same thing, and Sir Isaac himself in the next words calls it Rarity.

B. I should be glad to be informed concerning the expanding force of an elastic Fluid, I cannot possibly form any adequate Idea of the nature of it. What can be the Mechanism

(a) Sir Isaac Newton by allowing the Sun's Parallax to be 12" made the distance to be about 70,000,000 of Miles; whereas, according to later and repeated observations made with the most accurate astronomical Instruments, the Sun's horizontal Parallax is not much more than 8 seconds and an half, whence the distance of the Sun from the Earth cannot be less than 95,000,000 English Miles, and if to avoid Fractions, we are allowed to call it in round Numbers, 100,000,000, then, by analogy, the elastic Force of this Medium in proportion to its density must be, according to Sir Isaac's method of investigation, above 1,000,000 multiplied by 1,000,000, i. e. above a Million of Million Times greater than the elastic force of the Air is in proportion to its density, consequently we may be allowed to call it an indefinite number of times more rare and more elastic than the common Air,

cal cause of such an expanding force, and what can be the form of the primitive particles that constitute such a Fluid?

A. This is not easy to ascertain: Mr. Boyle was of Opinion that the primary particles of such a Fluid, fine as they are and imperceptible to the Sense, must be in form like so many little Watch-springs, coil'd and contorted in the nature of spirals, but infinitely more perfect, since these act every way, and every way alike in a spherical manner.

B. But if this spiral-like form of the Air be necessary to cause the elasticity of it, we must be allow'd to suppose the same spirals in Water, tho' an incompressible Fluid. The steam of boiling Water appears by its effects to be equally elastic with the Air. Water inclosed wou'd, if sufficiently heated, burst the strongest Vessel. In the *Æolipile* its elasticity is as manifest as that of the Air. Are the particles of Water then of a spiral-like form, and is the Supposition necessary?

If it is not necessary to account for the elasticity of Water, it cannot be so to account for that of the Air. It would be absurd to feign a set of springy particles in Water.

A. You seem to have forgotten what electricity has render'd most clear, *viz.* that the pores of all gross Bodies are replete with electrical Fire which is only a more pure Air, and is always expanded by heat. Steam is a composition consisting of the primary Air, Ether,

Æther, or true Fire, blended with the particles of Water (*a*). This Fire in the steam, is as elastic in the Æolipile &c. as in the common Air; but the elasticity of the steam is by no means the effect of the watery particles, but of that of the Fire in the pores of the Water.

B. Before we proceed any further you must give me leave to tell you that your Philosophical Principles seem to me so very heterodox, that I cannot call you a Newtonian; I shou'd therefore be glad to know what to stile you as a Philosopher; shall I call you a Hutchinsonian?

A. I was always a professed Enemy to Parties of all Denominations, (at least, ever since I was capable of judging) on account of the heat and animosities subsisting amongst them, and the illiberal Names they so frequently bestow on one another, even to the Scandal of all Parties, and therefore cannot help having an utter Aversion to Parties in Philosophy, as well as in Theology.

And as to the Hutchinsonians I never saw any of their Writings, and am consequently a stranger to their principles; tho', were I to distinguish myself as a Partisan, I should stile myself an *Electrical Philosopher*; for it is to Electricity alone that I am indebted for that small stock of Knowledge, which I have acquired in my Researches of Nature.

(*a*) See my first Principles in the Essays, Page 23. Article the Fourth.

Before the late great Improvements that have been made in Electricity, I had no thoughts of ever commencing Philosopher.—Because the Books that treated of Philosophy, and undertook to explain it, were for the most part obscure and perplexing, or else the Rules implied manifest Contradictions; for Example, if I had a Rule or Maxim laid down, to observe that all matter was inert, having no Affections or Properties peculiar to it as matter, but was intirely inactive and dead; I should have another, or perhaps two, that contradicted it; or which is the same thing, some of the most active properties were ascribed to it, such as Attraction and Impulse; i. e. Matter or Body in some Circumstances was indued with a mutual Attraction, in others with a repelling Force, both which active Properties were seated in the Bodies themselves.

Another position was that where Attraction ends a repelling Force begins, with other arbitrary maxims, which never were, or can be proved or reconciled.

Moreover when I came to look into Sir Isaac Newton's Principia, I had not read through his Preface, before I found that great Man himself complaining much of the many Ambiguities to be met with in Philosophy.—This, and the above mentioned Contradictions and Difficulties being laid together and considered, I must own I had no great Inclination to attempt what Sir Isaac called the *Search*

of

of Nature, being much more inclined to mathematical Studies; till of a sudden, a flood of light broke in upon us by means of the accidental Discovery of the Leyden Experiment, which cleared away the mist, and effectually convinced us that all matter was not, according to the received maxim, *inactive*; but that there were *active* particles likewise contained in it.

We then also found that instead of an universal Vacuum or emptiness throughout the whole system of nature, which was before a first and fundamental Principle, we had the greatest reason to believe the contrary, and that all Nature was replete with an elastic ærial Spirit, or elementary Fire; and that the want of that knowledge left an opening for all those difficulties and contradictions above mentioned: There then began to dawn, as it were, somewhat like an electrical, i. e. a rational Philosophy. — Instead of such an inconceivable mutual Attraction seated in the Bodies themselves to cause them to tend towards each other, that Phenomenon or tendency appeared to be the effect of the expanding force of the universal Fire just then discovered; and instead of such an unaccountable Attraction seated within the Bodies, the efficient cause of the gravitating tendency of them appeared to be extraneous; i. e. a Cause behind or beyond the Bodies impelling them, and causing them to tend.

A certain Author observes, “ That the
“ spirit of Disputing and an earnest desire to
“ obtain the Victory rather than come at the
“ Truth has been one of the greatest imped-
“ ments to the improvement of nature Know-
“ ledge. And that nothing occasions more
“ wrangling, than when different Persons an-
“ nex different Ideas to the same Words; for
“ Men can never rightly understand one ano-
“ ther till they mean the same things by the
“ same Expressions. That no disputes arise in
“ pure Mathematics, because the Definitions
“ of the Terms are premised, and every Body
“ that reads a Proposition has the same Idea
“ of every part of it.”

“ So that when any Man is so weak as to
“ think to bring one Demonstration in oppo-
“ sition to another, he is to be disregarded by
“ every one that would reason like a Philoso-
“ pher; for we may immediately put an end
“ to all Mathematical Controversies, by shew-
“ ing either that our Adversary has not stuck
“ to his Definitions, or has not laid down true
“ Premises, or else that he has drawn false
“ Conclusions from the Principles he has laid
“ down; or at least we must own that we do
“ not understand some part of his Demonstra-
“ tion, and desire him to explain it; for unless
“ we can shew where the Error or Paralogism
“ is, we must not condemn by the Lump,
“ but acquiesce with him in what he has
“ proved.”

Tis

'Tis indeed most certain that the neglecting to explain Terms has been the cause, not only of some of the greatest and warmest Disputes among Authors in general, but has also been productive of some of the worst Effects; for had Terms been explained, it had been next to impossible, that such palpable Contradictions should ever have been introduced into Science itself, as they most evidently have, particularly those of Attraction and Gravity.

Were Terms explained, no one would hesitate concerning the meaning of the word Attraction, or the drawing of one thing towards another; the same may be affirm'd of the meaning of the word Gravity or Weight. But if any one, engag'd in a Dispute, were to take the Liberty of using the Terms promiscuously, so as to mean either *Drawing or Weighing*, which he pleased, he by means of such an Artifice would have it in his power to play so fast and loose, that there would be no arguing with him.

Electrical Philosophers seem justly to wonder that ever it could enter into the Minds of Men to interpret two words (which are so widely different in their Signification from each other, as those of Gravity and Attraction manifestly are) so as to have any similarity or likeness at all, and much less that they should mean one and the same thing. Does not Dr. Friend argue much more consistently, who affirms, that Attraction is the Cause, and Gravity the Effect?

F

Have

Have not Gravity and Attraction the same relation to each other as any Effect and its Cause? With what Propriety then could they be deemed one and the same thing? Can it be thought any great matter of surprize, if a Philosophy, thus circumstanced, should be embarrassed with insuperable difficulties and perplexities, as could never have happen'd, had Terms been previously explained?

In a word — a neglect of explaining Terms seems to be one of the greatest, if not the principal Reason of the many perplexities and ambiguities in the current Philosophy, as it left room, at least, for the introducing of various Inconsistencies.

Dr. Derham, though allow'd to be an undisguised Author, seems to bespeak, as it were, the promiscuous use of these two Terms instead of one, although quite different in their Sense and Meaning. In his *Astro-Theology* — Book 6. p. 137. he undertakes to shew the great Usefulness of Attraction, but begins it with enquiring about Attraction or Gravity, as if both of them in conjunction had been allow'd to be one and the same Principle. But surely, these are such Liberties which can never be thought consistent with sound Reasoning.

Most certainly a Philosophy, embarrassed with so remarkable Difficulties as to require the Assistance that such miserable Auxiliaries are capable of affording it, can never be founded on rational and true Principles; and yet at the

the same time boasting of it as a Philosophy that had already arriv'd at the summit of Perfection.

How justly, I say, might we exclaim against a Philosophy, which affirmed that all Matter was inert, and yet in the next Breath ascribe to it the most active Properties, as Attraction in particular, although no Word can be more expressive of its Sense, or carry its own meaning along with it to signify a *Cause* or *active Principle* plainer than that does; yet it is immediately turn'd into an Effect; and Gravity, Cohesion, Magnetism, &c. all of them into *Causes*; as when we say, Attraction of *Gravity*, Attraction of *Cohesion*, Attraction of *Magnetism*, &c. &c. That Effects are frequently put in the place of Causes is notorious, and even *Motion* is often made use of to signify a *Principle* or *Cause*.

To prove this to be Fact, See p. 242 of the Essays, where you will meet with an extraordinary pompous Harangue on Motion, as a *Cause*, by Dr. Stephenson, Author of the mechanical Physician. I shall only cite a few Lines at the beginning of it, which may serve as a Specimen of the rest.

“ Among second Causes, Motion is the
 “ principal immediate *Agent* and *Instrument*
 “ of all the Effects, Operations and Phenomena
 “ that are produc'd in the material Universe,
 “ and is the primary *Cause* upon which the
 “ *Power, Force, and Energy* of every Body,

“ or System of Bodies wholly depend, &c. &c.

“ (a).”

B. How do electrical Philosophers avoid the like Absurdities ?

A. There can be no other effectual way, than by explaining Terms with Precision, and having alway a strict Regard to their Definitions, in order to guard against either Mistake or Design.

B. Why do you affect to make so many Quotations and Transcripts from other Authors ?

A. You mistake, it is not Affectation : But as I never pretended to be learned myself, I am sensible that whatever I advance, be it ever so worthy of notice, will be but coldly receiv'd, and that merely on account of my want of what is called *Learning* : My Reason therefore for so many Quotations is, that what I advance may have the sanction of the more learned, particularly, when they are found to agree with and confirm my Reasoning.———*This I shall take for granted to be sufficient to satisfy the judicious and candid Enquirer.*

(a) See Dr. Stephenson's Assertion on Motion as a Cause, in Essays, Page 242. Section 151.



DIALOGUE. IV.

Tenets of electrical Philosophers.——

Advantages they are possessed of beyond others.——Dr. Clarke's dispute with Monsr. Leibnitz.——Fire, the grand Desideratum being discovered, our Reasoning is now a priori.——

Concerning mechanical Agency.——

Lord Bacon on the same.—— Reason for prefixing so humble a Motto to the Essays.—— Fire, but one kind of it, and what that is.

B.  H. A T do you mean by an Electrical Philosopher?

A. By an Electrical Philosopher, I mean, one who is become a Philosopher, merely from the Knowledge acquir'd from electrical Experiments: And by electrical Philosophy, I mean, a Philosophy founded on electrical Principles.

B. What are the Tenets, which are maintained by electrical Philosophers?

A. " That the Frame of Nature is a perfect
" and well order'd Machine; or in other words,
" that the visible System of the World was
" created,

“ created, disposed, and set into motion by the
 “ Finger of God; acts as a Machine does, a
 “ Connexion and Communication being pre-
 “ serv’d between all the distant parts of it; for
 “ if the Contact of a Machine be interrupted,
 “ the Motion is destroy’d in all those parts
 “ from which the Communication is cut off.
 “ More particularly, such Philosophers assert,
 “ that the fluid ætherial Matter of the Heavens
 “ acts by Impulse on the solid Matter of the
 “ Earth, is instrumental in every one of its
 “ Productions, and necessary to all the stated
 “ Phenomena of Nature.”

“ Hence they divide the Elements into ac-
 “ tive and passive; not that they are such by
 “ any inherent or essential difference; but that
 “ according to the Order established by the
 “ Divine Architect, they are observed to subsist
 “ under these different Relations.”

B. What Emoluments are electrical Philo-
 sophers possessed of beyond others, which they
 were Strangers to before?

A. Many, and very remarkable ones, some
 of which I shall mention,

First, Fire in particular, which one should
 naturally imagine to be one of the most fami-
 liar subjects, yet, before it was illuminated by
 Experiments made in Electricity, there are few
 things of any Consequence of which we were
 much more ignorant. Before that time we
 knew so little of the nature of Fire and Heat,
 that we imagined them to be one and the same,

con-

consequently, as we were certain that Heat could be generated and destroyed at pleasure, it must have been a Contradiction to suppose that Fire was a permanent Principle. —

We had no Criterion, no infallible mark or distinguishing Characteristic to point out to us that Fire was a more permanent Principle than Heat, till Electricity taught us to make a proper Distinction between them.

Secondly, Since Fire has been discover'd to be a permanent Principle, we are enabled to give a rational account of the Cause of Motion in the World, which is such an Advantage we never before could arrive at.

Thirdly, Before the grand Desideratum was discover'd, we contented ourselves, when treating of Gravitation for example, with saying, such and such things were effected by Gravity, not considering that Gravity itself was only the Effect, and that consequently these things were brought about by the Cause of Gravity; this being the case, it could be no wonder if Philosophy was in a very perplex'd state, especially as we so confounded Terms, particularly those of Gravity and Attraction. We adopted Attraction as a first Principle, and when we had it, knew not what to make of it; for although we adopted it as a first and fundamental Principle, yet at other times we could allow it to be no more than a mere Phenomenon (a).

(a) Dr. Samuel Clark undertook to vindicate Attraction when attack'd by Monsieur Leibnitz and others, and replied—
How—

However this was not our fault, but rather our misfortune, since it was owing to the imperfect state Philosophy was then in.

Fourthly, Another Advantage which we possess beyond others is, that whereas none before the Discoveries that have been made by means of Electricity could possibly know any thing of the nature of Fire, nor hardly what was meant by the Term elementary Fire; Electricity has discover'd and verified elementary Fire itself, and that in so plain a manner, as even to realize it to the Senses, and at the same time we are assur'd it is in form of a most exquisitely fine, pure Air or Æther.

While Men remained so entirely ignorant of Fire, as not to be able to know whether any such Principle existed, it was impossible for them to know how to distinguish between Fire and Heat; they therefore concluded them to be the self same thing, and finding, as before

* It is very unreasonable to call Attraction a miracle and an unphilosophical Term, after it has been so often distinctly declared that by that Term we do not mean to express the Cause of Bodies tending towards each other; but barely the Effect of this Cause, or the Phenomenon itself, discover'd by experience, whatever be or be not the Cause of it. Gravitation or Attraction in this Sense (he adds) is an actual Phenomenon of Nature." And again; "Philosophers therefore may search after and discover that Cause if they can, be it Mechanical or not Mechanical; but if they cannot discover the Cause, is therefore the Effect itself the Phenomenon, or the Matter of Fact discovered by Experience (which is all that is meant by Attraction and Gravitation) ever the less true?"

hinted.

hinted, that Heat could be generated and destroy'd at pleasure, they for that reason thought it a sure sign that Fire was not a durable Principle any more than Heat; and what seem'd most remarkable, no one could be much more mistaken than Sir Isaac Newton himself, as was manifest from his asking if a red-hot Iron was not Fire?

Fifthly, Before the Discovery of Fire as a permanent Principle, we could never attempt to explain the Phenomena of Nature, otherwise than from first endeavouring to investigate the Laws by which they acted.

We now, with much greater readiness, account not only for the Laws, but the *Cause* of such Phenomena, consequently our Reasoning is now *a priori*. Fire, the grand Desideratum, being discover'd, we can with equal Propriety proceed from the *Cause* to the *Effect*, which is such an Advantage as was not attainable before.

Sixthly, Another Emolument, no less favourable and satisfactory than any of the rest, is, that since the discovery of an elementary Fire, a variety of the most abstruse Phenomena of Nature, which were unaccountable before, are render'd clear and intelligible, and a general mechanical Agency appears more and more conspicuous. — The Rev. Mr. Jones observes, that “the Writings of our modern Reasoners, whether Metaphysicians or Mathematicians, are stored with Objections, not
G “ only

“ only against the reality, but even the possibility of a *mechanical Agency* (a).” But however, the Light now reflected on the Works of Nature in general has left much less room for such Objections.

To illustrate the Doctrine of a mechanical Agency, I shall quote a Passage out of the above-mentioned Book, which appears to put the reality of a general Mechanism past dispute.

“ That God does,” he says, “ in many Cases, govern the World by material Agents, and conserve the Motion of Bodies by the activity of secondary Causes is beyond dispute. The support of animal Life by Breath; the motion of a Ship before the Wind; of the Sap in Vegetables at the approach of the Sun’s Light; of the Mercury in the Barometer by the pressure of the Air; of the Fluid in a Thermometer by the expanding Power of Fire; of Bodies impell’d and driven off again by the flux and reflux of electrical Æther, with innumerable other Phenomena of Nature, all conspire to establish this plain Truth. And if it be an axiom in Physics, that more Causes are not employ’d where fewer will suffice, how comes it to pass that those Agents, which confessedly minister to so many and great Effects, are not sufficient for the producing of all? Shall

(a) See Mr. Jones’s first Principles of Natural Philosophy, Page 10, or p. 272. of the Essays.

“ we

“ we allow that God governs the World by a
“ subordinate agency and mechanism in some
“ cases, where that agency appears to us, and
“ deny it in others, merely because we have
“ lost sight of it, or because it would make
“ against us? A Philosophy, that labours un-
“ der this difficulty, and is one while working
“ with a material Cause, and in the next
“ breath with an immaterial one, be it ever
“ so ingeniously put together, will after all be
“ liable to this grand exception; at best, it is
“ inconsistent and unworthy of God. Every
“ Body must see and know, that there are ma-
“ terial Causes acting in the World; and he
“ that denies it must deny his Senses. If these
“ Causes are not sufficient to perform all the
“ stated Operations of Nature, then the Creator
“ hath made use of such means as are not pro-
“ portionable to the end. If the Creator him-
“ self performs them by the immediate agency
“ of his own Substance, then is there no need
“ of any other Causes; they are all superfluous.
“ But that there are other Causes is abundantly
“ evident; therefore they must be capable of
“ answering their end, and every material Ef-
“ fect will be immediately owing to a material
“ Cause. What I here say is grounded on this
“ reasonable Postulatum, if it may not rather
“ be called an Axiom, that the Wisdom of
“ God is consistent with itself in its Operations;
“ and that he wants neither Power nor Skill
“ to avoid the error of Inconsistency: Grant

" but this, and the Argument, amounts to a
 " Demonstration." See his first Principles, p.
 30.

I shall here just mention a Passage from
 Lord Bacon's Works, taken notice of by the
 same Author. — See his first Principles,
 p. 220. " where he remarks, that there is not,
 " in all the course of his Writings, so heavy a
 " Censure, as that which he thought proper to
 " pass on those who denied an universal Me-
 " chanism of Nature. "

" Certain it is, " (says that renown'd Philo-
 sopher) " that God worketh nothing in nature,
 " but by SECOND CAUSES: And if they
 " would have it otherwise believed, it is mere
 " Imposture, as it were, in favour towards God,
 " and nothing else, but to offer to the Author
 " of Truth, the unclean sacrifice of a Lye. "

B. Have you any thing more to observe, in
 general relating to this new-fangled System
 of Philosophy ?

A. That we, who are Professors of it, are
 become Converts merely upon Conviction;
 for when we first began to scrutinize and exa-
 mine the current Philosophy, and had consid-
 er'd, that its first Principles were an universal
 Vacuum, and an Attraction, whereas the elec-
 trical fluid being so extremely elastic and sub-
 tile, as to pervade all other Bodies, we naturally
 concluded, that instead of such a Vacuum, there
 must necessarily be an universal Plenum, since
 a fluid so extremely elastic, and yet so extremely
 rare,

rare, could never be at rest till all parts were equally full; and that consequently hitherto we must have been wrong in almost every thing. We therefore judg'd it rational to make trial of a different System, and found it upon Principles diametrically opposite; this being put into execution succeeded according to our Expectations and Wishes, and I can with great pleasure and truth assure you, that the more we pursue it, the more it seems strengthened and confirmed; and although we have had some years trial of it, we never had the least reason to alter our opinion concerning it. This gives us great encouragement to believe that we have luckily pursued the search of nature, till we have discover'd true Science, flowing, as it were, in its own native channel.

What gives us the greatest reason to presume that our Philosophy is now flowing in the true channel, is, that our Experiments are seldom or never observ'd to clash with one another when explain'd on the above mention'd Principles, though ever so much varied and diversified. — Nor is it one of the least advantages, that now a Man may become a very intelligible Philosopher, without the assistance either of much mathematical Learning, or of any other Language than his own, consequently the Knowledge of natural Philosophy will now be a much easier Acquisition than it ever was before.

B. How came you to think of prefixing so humble a Motto to your Essays? A.

A. I hardly know why I prefix'd any, but only as a Motto is customary. However a principal reason why I made choice of one of that kind was to intimate, that I consider'd myself as no way possessed of any extraordinary natural Talents; yet, that I thought myself certain I had stumbled on a true method of philosophizing, from the light we received from the discovery of electrical Fire, which Electricians of much superior Parts and Learning had either heedlessly neglected, or else thought not worth their notice.

Indeed, ever since the first Discovery of this wonderful Power of Nature, I have had as great a propensity, as others have shewn an aversion, to cultivate an enquiry into its Nature, Office, and Use.

What a number of Experiments do we find in Dr. Priestley's copious History of Electricity, and not one of those Electricians make the least enquiry concerning the Uses for which it was ordain'd: Those they have made the subject of their enquiry appear merely trifling, when compar'd with those relating to its Uses.

It was thought somewhat remarkable, that Dr. Priestley himself, who had perused so great a number of Authors on Electricity (as by his Catalogue we find he had) never once mentioned the Plan on which I proceed, notwithstanding he inserted my Essays in his Catalogue of Authors, just as if the spirit of philosophizing, lately so predominant, had all on a sudden vanished and forsaken Mankind.

B.

B. What then do you take to be the reason of that Disinclination which is shewn to an Enquiry, which in your Opinion promises the most important Discoveries ?

A. I can think of none, unless it be, that this electrical Fire, appearing with a train of Tokens and Indications of Universality, should disconcert Philosophers, by leaving no room for their adopted Vacuum ; otherwise it was natural to expect, that Dr. Priestley would have said, whether my Enquiries into its Nature and Uses, were approv'd or disapprov'd of.

B. I must further beg to be inform'd how to make a proper Distinction between the different kinds of Fire, as elementary Fire, solar Fire, the Fire of Lightning, of Electricity, of culinary and subterraneous Fire ; and in what respect elementary Fire differs from the rest ?

A. Electrical Philosophers have but one kind of Fire, namely, the pure elementary Fire, the rest being all different modifications of the same homogeneous Fire, acting in different Conditions and Forms. The solar Fire is doubtless of the same elementary kind ; but we could not imagine there was any besides so pure, till we were agreeably disappointed by finding the electrical Fire to be such, since that is so exceedingly pure, as, like the Rays of the Sun in the Focus of a burning Glass or concave Speculum, to yield neither Smoke, Ashes, or other gross feculent Matter. To suppose more kinds of Fire than one is deem'd unphilosophical,

con-

consequently, even that which Dr. Priestley calls natural Electricity must be the same Fire in a different dress; That I shall explain to you a little farther on, and shall give you the Doctor's own Account, from the 2d. Edition of his copious History. Period 10. Section 12.

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## DIALOGUE. V.

*Gravitating tendency of Bodies accounted for, by the current Philosophers.—Whether the whole System of Nature was created to be properly furnished, or to remain empty?—Whether the gravitating tendency of Bodies toward each other be the Effect of an exterior or interior Force?—Sir Isaac Newton's diffidence with regard to the Truth of his own Philosophy.—Equal to the Geometrician, whether his first Principles be real or only imaginary.*

A. { BEFORE I proceed farther, I  
 B. { beg to ask you a Question or two.  
} How does the current Philosophy  
} account for that gravitating  
 Tendency which is so obvious among Bodies?

B.

**B.** All Bodies, and all Matter, and Particles of Matter, have both an attracting and a repelling Property inherent in the Bodies themselves; and where Attraction ends, a repelling Force begins.

**A.** As for Attraction, I must confess, I can form no tolerable Conception of it, and much less, that the same matter should both attract and repel, since two such Principles in the same Body must destroy each other. Besides, is it not an allow'd maxim in Philosophy, that matter is inert, having no Affections, Powers, or Properties? If then matter be inactive and dead, how came Philosophers to contradict their own receiv'd Positions so far as to ascribe active Properties to inactive matter? as Attraction, Repulsion, &c. Attraction of various kinds, as Attraction of Gravity, Attraction of Cohesion, Attraction of Magnetism, electric Attraction, &c. &c.—The Sun attracts the Planets, and the Planets the Sun, and one another. By Attraction they account for the Tides, and most other difficult Phenomena. I desire therefore to know how these things are reconciled?

**B.** Your Questions seem somewhat captious; surely you think to sap the very foundation of the Newtonian Philosophy; or at least to give occasion of great Diffensions among Philosophers.

**A.** You never were more mistaken in your Life; my sole Intention is just the reverse. Electrical Philosophy is altogether pacific, and tends to unite Philosophers, and to put an end

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to



to their halting between two such different and contradictory Opinions, as that of an absolute Vacuum, and that of an universal Plenum of elementary Fire.

To prove which of us is in the right, let us put the dispute to the test, by enquiring, first, which appears the most rational Philosophy, that which is founded on an universal Plenum, or one founded on an absolute Vacuum; or in other words, whether the whole System of the Universe was created to be properly furnished, or to remain empty for ever. — The Answer appears so obvious as scarce to admit of hesitation. Secondly, Which seems the most reasonable to suppose, that the cause of Bodies tending or gravitating towards each other is a mutual attracting force, seated in the Bodies themselves, or whether the effect of an impelling extraneous force, the force of an universal elastic medium behind or beyond the Bodies?

How the latter may be perform'd is obvious and clear enough to the Understanding of every one; but no one can form any rational Idea of the former. Even the greatest Votaries for the Doctrine of Attraction differ essentially themselves about the manner how it is perform'd; nor can they even so much as agree, whether it be a Cause or an Effect, as the Rev. Mr. Jones has indisputably prov'd, in Book 2d. Chap. 2d. of his first Principles of Nat. Philosophy. See a Quotation of the same in the 8th Chap. of the 3d. part of the Essays, p. 331. where it is discuss'd at large,

large, the whole of which I shall not at present trouble you with, but shall just give a brief summary, which Mr. Jones has drawn up; where he produces the several Authors giving their Verdict in their own Words. *Essays*, p. 342.

Sir *Isaac Newton* — “Gravity exists and acts.”

Dr. *Friend* — In explaining Gravity, says, “Newton has demonstrated it to arise from an attracting force.”

M. *Maupertius* “It should be remember’d in justice to Sir *Isaac Newton*, that he has never consider’d Attraction as an explanation of Gravity. He considers it not as a Cause, but an Effect.”

Dr. *Cotes* — “Gravity is the most simple of Causes.”

Dr. *Clarke* — “It has been distinctly declared, that by the Term Attraction, we do not mean to express the Cause of Bodies tending towards each other, but barely the Effect, the Phenomena or matter of fact.”

Dr. *Desaguliers* — “Attraction seems to be settled by the great Creator, as the first of second Causes.”

M. *Rowning* — “When we use the Term Attraction, we do not determine the physical Cause of it, but use it to signify an Effect; nevertheless, to Attraction Effects are manifestly owing.”

Sir *Isaac Newton* — “There are Agents in nature

"nature able to make the particles of Bodies  
 "stick together by very strong Attractions,  
 "and it is the business of experimental Philo-  
 "sophy to find them out."

Dr. Desaguliers — "We are not solici-  
 "tous about the Cause of Attraction,"

Dr. Friend — "I believe Attraction will  
 "always be occult."

"This is the result of my enquiry," says  
 Mr. Jones; "and if any Person should be so  
 "inclin'd, he is welcome to lay all the blame  
 "on my want of Understanding. But if these  
 "learned Men, who are all vindicating the  
 "self same Principles of Philosophy, had no  
 "clear Ideas of what they affirm'd, and could  
 "not understand one another, 'tis no wonder  
 "if the world should be at some loss to under-  
 "stand them."

B. If there never was in reality such a thing  
 as Attraction, how came such a Principle to be  
 so generally receiv'd as it has been?

A. Attraction in Philosophy, like Epicycles  
 in the ancient Astronomy, was a mere invention  
 to solve appearances; nor had Attraction ever  
 been thought of, could any other expedient  
 have been found to supply its place; for even  
 when it was adopted by them, it would by no  
 means serve the purpose they designed, unless  
 they were sometimes allow'd to call it Gravity;  
 that is, though it was receiv'd as a Cause, it  
 would not serve the turn, unless it was also al-  
 low'd, sometimes to be explain'd, as an Effect.

Is



Is it not strange, as the Newtonians found themselves so embarras'd with insuperable difficulties relating to the Term *Attraction*, that at the discovery of the electrical fluid, a Principle so powerful and extensive as that appear'd to be, they never attempted to examine it, so far at least, as to try whether it was not capable of affording them some assistance towards a truer Philosophy than their own, or else to direct them to a Philosophy, which was attended with fewer difficulties than that which they were in possession of.

It would be natural to expect after such a notable discovery of so surprising and powerful a force as the electrical Fire proves to be, that they would have set to work with one consent, and cultivated the discovery, in order to enquire whether it would not afford sufficient light, either to extricate them out of the insuperable difficulties attending their Philosophy, or else assist them in directing them to some truer method of Philosophy than what they had attain'd to before.

B. I never heard of any very remarkable difficulties that attended the Newtonian Philosophy, but the reverse; and that it is generally allow'd, by Men of the best Understanding, to be the only true System that ever appear'd in the World.

A. If Sir Isaac Newton himself may be allow'd to be a competent judge, it is not a true System of Philosophy, and for this reason, because

cause it is attended with the greatest difficulties.  
 — Had he been certain that Philosophy was fixed on a firm basis, he would never have published its difficulties to the World in the Preface to his Principia, where he informs us, whence difficulties in Philosophy, in general, arise.

“ All the difficulty of Philosophy,” he says, “ seems to consist in this, from the Phenomena of motions to investigate the Forces of nature; and then from these Forces to demonstrate the other Phenomena; and to this end the general Propositions in the first and second Books are directed. In the third Book we give an Example of this, in the explication of the System of the World. For by the Propositions mathematically demonstrated in the two first Books, we there derive from the celestial Phenomena, the Forces of Gravity with which Bodies tend to the Sun and to the several Planets. Then from these Forces by other Propositions which are also mathematical, we deduce the motions of the Planets and Comets, the Moon and the Sea. I wish we could derive the rest of the Phenomena of Nature, by the same kind of reasoning from mechanical Principles. For I am induced, by many reasons, to suspect, that they may all depend upon certain Forces, by which the particles of Bodies, by some causes hitherto *unknown*, are mutually impell’d towards each other, or are repell’d and recede.”

“ recede from each other, which forces being  
 “ unknown, Philosophers have hitherto at-  
 “ tempted the search of nature in vain. But  
 “ I hope the Principles here laid down will  
 “ afford some light, either to that or some  
 “ truer method of Philosophy.”

Of this Complaint of Sir Isaac, concerning the difficulties attending the search of nature, i. e. of natural Philosophy, I have taken notice before, in my Essays, p. 141. to shew how Philosophy was embarrassed before the discovery of a Medium more subtile and elastic than common Air.

It is clear beyond all doubt, that an attentive Reader of Sir Isaac's Writings will find, that he fluctuated between two different and contrary Opinions; viz. that of an universal Vacuum, and that of an universal Plenum; his Principia inclining to the former, and several of his Queries to the latter.

In the second Advertisement of the third Edition of his Optics, he informs us, that to shew he did not take Gravity for an essential Property of Bodies, he had added a Question concerning its cause, which he supposes to be a subtile ætherial Medium, — readily pervading all Bodies — expanded through all the Heavens — causing the Gravity of those great Bodies (the Comets, Planets, &c.) towards one another, and of their parts towards their Bodies — and such as may suffice to impel Bodies from the denser part of the Medium towards



towards the rarer, with all that power which we call Gravity. Optics, Query 18, 19, 20, 21 (a).

This the Rev. Mr. Jones has taken notice of before, p. 75. of his first Principles of natural Philosophy.

Any one might reasonably suppose, that the thought of a subtile Medium in the pores of all Bodies, was almost always uppermost in Sir Isaac's Mind, even while he was Writing his Principia, since he concludes it with informing us, that "*now he might add something concerning a certain most subtile Spirit, which pervades and lies hid in all gross Bodies; by the force and action of which Spirit, the Particles of Bodies mutually attract one another at near distances, &c. &c. (b).*"

But, pray inform me ingenuously, why you suppose such a Vacuum and an universal emptiness throughout luxuriant Nature?

B. For many Reasons, but particularly on account of the regular and unretarded motions of the Planets, both primary and secondary, in their several Orbits; since, notwithstanding they have a compound motion, their periodical Revolutions are always performed in exactly the same space of time, which must be a proof that they move in a Space where there is no Medium of any kind to disturb, obstruct or retard their Motions.

(a) Essays, p. 348.

(b) See his Princip. p. 393, or Essays, p. 36. 37.

Besides,

Besides, an universal Vacuum is absolutely necessary to conserve that constant and undecaying motion which we observe among the planetary Bodies; for be the elastic Medium ever so rare and fine, it must resist in some degree, which in length of time would become sensible; whereas the motions of the Planets have continued the same, without the least alteration, ever since the first commencement of Astronomy, consequently, there must necessarily be a Vacuum, by which means, and the force of a mutual Attraction, a gravitating tendency of Bodies towards each other is accounted for in a rational and satisfactory manner. — What confirms the truth of these things, so as to put them past dispute is, that they are demonstrably prov'd by Sir Isaac Newton's mathematical Reasoning in his *Principia*: Had he not been fully persuaded of the truth and certainty of a celestial Vacuum, can it be reasonable to suppose, he would ever have undertaken and executed such a work as his *Principia*?

What indefatigable Pains, as well as fixed Resolution, must it require to go through such a number of laborious Calculations, in order to obtain the many useful Theorems contained therein? And, as was observ'd above, what must necessarily prove the truth of the Opinion is, that the general Phenomena, which are observed to prevail throughout Nature, are solved by these two Principles, viz. those of an universal Vacuum and a mutual Attraction of Bodies,

dies, even to a mathematical Demonstration.

— Is not this Consideration alone a sufficient proof of the truth of the Assertion?

A. By no means: For as the Rev. Mr. Jones very justly observes on the same, " 'Tis equal  
 " to the Mathematician, whether his first Prin-  
 " ciples are only imaginary and hypothetical,  
 " or whether they are real; the Operation will  
 " go on as smoothly, and the Conclusion come  
 " out as readily in the one case as in the other;  
 " and if hypothetical and real Forces will  
 " equally afford matter for an Astronomer to  
 " work upon, we may appeal to the judge-  
 " ment of any ingenuous Man, sufficiently  
 " versed in mathematical Studies, whether the  
 " Phenomena above mentioned, i. e. whether  
 " a mutual gravitating tendency of Bodies to-  
 " wards each other may not arise from a pres-  
 " sure *behind* as well as from an attraction  
 " *before*, and whether Sir Isaac's geometrical  
 " Reasoning will not be as conclusive in the  
 " one case as in the other (a)." p. 92. of his  
 Nat. Philosophy; or at p. 369. sect. 156 of the  
 Essays.

If then it cannot be determined by mathe-  
 matical Reasoning, whether an universal Ple-

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(a) Example, Let  $x$  be a Plenum,  $y$  the impelling Force, and  $z$  the gravitating tendency. Then it will be,

As  $x$  is to  $y$  so will  $z$  be to  $\frac{yz}{x}$ , consequently it will be the same if  $x$  be put for a Vacuum,  $y$  for Attraction, and  $z$  the gravitating tendency, for then  $x$  is to  $y$ , as  $z$  is to  $\frac{yz}{x}$ , as before.



num exists in the celestial Regions, or whether an absolute Vacuum; in order therefore to succeed in our enquiries, we must have recourse to Reason, Argument, Experiment and Observation.

## DIALOGUE. VI.

*Fire the Cause of Motion——Laws observ'd by falling Bodies——A remarkable Deception——Of a perforation through the Earth——Of the Antipodes——Cause of the Tides.*

A. **H**ERE it may not be unnecessary to observe again, first, that matter according to all Philosophers is inactive and quite motionless, having no Affections, Qualities, or Properties peculiar to itself, but is entirely passive. Secondly, that since the World appears replete or full, as it were, of motion, it must necessarily proceed from some active Principle or Cause. But, it seems, no active Principle was known beyond that of the common Air or Atmosphere, till another much more active was happily discovered by means

of the electrical Apparatus, and in form of fire, that allow'd active Principle and cause of motion, which Fire, on the strictest examination, is found to be the self same with that of Lightning (a); and by what appears from the nicest Observations is every where dispersed. Quære, which then seems most consistent and rational, an universal Vacuum throughout the celestial Regions, and a mutual Attraction of Bodies, notwithstanding their component parts are inert, or whether an universal Plenum of the elastic, *active* Principle, and an impelling Force; that is, whether a Vacuum and an interior Attraction between Bodies, or whether a Plenum and an exterior Pressure from beyond them?

But exclusive of our Physico-mechanical Experiments, there are others of a more physical Nature, which point out a motion of the æthereal Matter where it is seldom observ'd, although it be incessantly descending from the upper Regions, and passing through such Iron Bars, as are particularly described in the Essays, p. 78. 406. and 421.

There are besides those, still other natural Appearances whereby such a descent of an active Agent is discover'd to be perpetually passing down from the upper Regions to the Earth, which are render'd plain and obvious, particularly, when we enquire concerning that Law or Degree of Proportion of the Accelerat

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(a) Saving that the electrical Fire is much more pure than the Fire of Lightning.

tions observ'd by falling Bodies, which Law, though it has not hitherto been so much consider'd as some others, is yet sufficient to conduct us to many very useful and remarkable Truths, especially, when we consider the Effects of the above-mentioned electrical Philosophy.

**B.** What is the Law that is observ'd by falling Bodies, for I have almost forgotten it?

**A.** First, their Acceleration is, as the Increase of the times or moments taken up from the beginning of their fall, in an arithmetical Progression of the most simple series, viz. 0, 1, 2, 3, 4, &c. whose excess and common difference is one, and for that Reason their Squares increase according to the odd, i. e. the uneven Numbers, 1, 3, 5, 7, &c. See the Essays, p. 406. Secondly, Bodies are observ'd to descend about the Space of 16 feet in the first Second of Time from the beginning of their fall; therefore since sixteen feet and an half is one perch or pole and 320 poles is one mile, I shall call 16 feet a Pole, and then 320 of those poles will also be one mile. — The above mentioned Numbers and the Acceleration of falling Bodies will be more easily understood if committed to Writing, as in the following Tablet.

Seconds.



| Sec. | Squares. | Diff.  |
|------|----------|--------|
| 0    | 0        | of Sq. |
| 1    | 1        | 1      |
| 2    | 4        | 3      |
| 3    | 9        | 5      |
| 4    | 16       | 7      |
| 5    | 25       | 9      |
| 6    | 36       | 11     |
| 7    | 49       | 13     |
| 8    | 64       | 15     |
| 9    | 81       | 17     |
| 10   | 100      | 19     |

The first of the three Columns in the Margin exhibit the Seconds of Time.

The next Column are the Squares of those Seconds.

The third Column contain the Differences of the Square Numbers.

The Sum of those Differences or odd Numbers, 1, 3, 5, 7, &c. counting upwards, are always the Square of the Number of Seconds from the beginning of the Fall.

#### EXAMPLE.

The Sum of the 2 first is 4 = the Square of 2.  
 The sum of the 3 first is 9 = the square of 3.  
 The sum of the 4 first is 16 = the square of 4.  
 The sum of the 5 first is 25 = the square of 5.  
 The same of the rest, be there ever so many.

A Method so concise, and so very easy to discover the Time in which a falling Body will describe

describe any given Distance, excited my Curiosity to enquire, how long time a Body would require to descend to the Centre of the Earth, which Distance in round Numbers may be called 4000 Miles.

### SOLUTION.

Since the number of Poles or Perches contain'd in one Mile is 330 such Poles, viz. Poles of 16 Feet, consequently the number contain'd in 4000 Miles is 1320000 poles, the Square Root of which is 1148,9 = the number of Seconds which the descending Body would require to arrive at the Earth's Centre, supposing it pass'd through a free and open space, i. e. = about 19 minutes.

Here then are two things worthy of notice : First, that although in the first Second of time its descent would be no more than one pole, yet so violent is the *Impetus* or *Cause* of the Accelerations, that in the last Second of time, its descent at the same rate, would be no less than 2295 of such poles i. e. almost 7 Miles. Secondly, that the same cause prevails at every particular point of the Earth's surface, since Bodies descend with equal celerity and freedom from every individual part of it, consequently the cause of Gravity is general.

What a Violence this, which like an impetuous torrent thus pursues the descending Body ! How unlike is it to the greatest Force that

that can be employ'd by human Art; since all other forces are constantly diminishing as soon as begun, whereas the accelerations of falling Bodies towards the Centre of the Earth, is always increasing according to the Square of the times from the beginning of the fall? —

This natural tendency of all Bodies towards the Centre of the Earth, at every point of the surface, furnishes us, not only with the cause of Gravity in general, but with the most remarkable deception, with respect to the cause of the Gravity of our own Bodies; which, altho' we have all the certainty that is possible, from Reason and Experience, as well as from falling Bodies to convince us, that the cause of our gravitating tendency towards the centre is an exterior pressure; yet that pressure operates so naturally, so constantly, so regularly and so imperceptibly on every part and particle of our Bodies, that it appears to us to be a real internal Weight, just as if it were inherent, and seated within us. This Deception is so remarkably prevalent, and the Sense is so deluded, that we cannot possibly overcome the fallacy. — Since then we are sure to err and be misguided by the evidence of Sense, the only sure method to conduct us to truth is, to consult the more unerring testimony of our Reason, which assures us, even to a demonstration, that the Cause is external.

B. Of what real Advantage can the investigation of this Deception be to Philosophers?

A. Unless we were previously apprised of such



such a Deception, we should be unable to explain the Doctrine of the Antipodes in a rational and satisfactory manner.

*B.* How does the discovery of that deception enable Persons to explain it?

*A.* By informing them, that so long as they can stand or sit upright, so long the Earth appears beneath them; and thus the doctrine of the Antipodes is easily and naturally explained thereby. ——— Electrical Philosophers therefore, and all others, may now very justly admire, that the cause of Gravity was not known before.

From the consideration of falling Bodies we are furnished with a variety of useful hints, and many Conclusions may be safely deduced from them.

*First,* That although the figure of the Earth is a Sphere or Ball, yet Bodies have the same inclination or propensity to descend towards the Centre from every individual part of it; this is an undoubted proof that the *Cause* or *accelerating Force* is general.

*Secondly,* From these Considerations it as evidently follows, that it is an exterior *Force* or powerful *Pressure*, incessantly impelling the descending Body towards the Centre. ———

Hence, the Earth necessarily, as it were, puts on that spherical Form.

*Thirdly,* The doctrine of the Antipodes will also be illustrated by considering the Phenomena of falling Bodies. And as all Bodies have

a natural tendency towards the Centre of the Earth from every part of the surface, this consideration will serve to lessen what is held by many as one of the greatest Paradoxes in Nature, namely, that every individual point of a Sphere or Globe should appear *uppermost* to the Inhabitants, where-ever situated.

This Paradox is likewise solved by considering, that Bodies appear, when view'd, according as the Retina of the Eye is posited; for if we view an Object with the Eye inverted, the Object, for that reason, appears inverted; or if a Picture, &c. be set bottom upwards, and view'd with the Eye inverted, the Picture then appears erect, consequently, so long as we stand or sit upright (the lower part of the Retina being then nearest to the Earth) so long the Earth will appear beneath us, since according to the position of the Eye, so Objects necessarily appear.

*Fourthly*, From the premises ariseth, perhaps, as great a Paradox as the former, which is this; were we to suppose a perforation quite through the Globe of the Earth, and that space were free and clear from a resisting Medium, in the space of 19 minutes a falling Body would arrive at the Centre of it, viz. 4000 Miles, nearly; at which place it would meet with such a resistance, as it had overcome but just before, which, though check'd in its career, must still continue its rectilinear or right-lin'd course, would, after it had passed the Centre, be, as it were,

were, moving upwards, consequently still more and more retarded, till it arriv'd at the Antipodes, at which time the motion would be spent and quite at an end; after which, it would begin again to descend towards the Centre as at first, and the whole process be repeated: Thus it would continue to vibrate as a real Pendulum, whose point of suspension was the Center of the Earth, and the utmost extent of its Oscillation at parts of the surface diametrically opposite, that is, at those parts of the Earth, where the Inhabitants were Antipodes to each other.

## ILLUSTRATION.

It is well known to every Astronomer, that by reason of the diurnal rotation of the Earth, all Inhabitants at the Equator, who are Antipodes to each other, necessarily change places every 12 hours; that part of the Heavens which is the Zenith to the one, is 12 hours after the Zenith to the other.

Amongst a variety of Indications that appear to point out an universal Plenum, the most promising one is, that of falling Bodies; for from thence we are furnish'd with sufficient Data to proceed in many other Enquiries: By the assistance of that Phenomenon, the Universality of the subtle Fluid is clearly and rationally pointed out, as likewise, that it is exceedingly elastic, and acts by pressure on the Earth, and all plan-



netary Bodies.

From the above Consideration of such an universal exterior pressure on every part of the Earth, electrical Philosophers sometimes take the liberty to query, whether the cause of such an universal pressure had any share in the first formation of the Earth; since, if it had not at first been so uniform, but of any multiform figure, such a violent universal pressure would necessarily cause it to put on the globular form in which it now appears: Or had all the assemblage of the parts and particles of matter of which the Earth is composed been ever so wide asunder at the first, such an universal pressure would naturally close the parts, and cause them to unite in a Sphere: However, such a violent pressure on all parts of the Earth as is exhibited by that truly physical Experiment, is abundantly sufficient to account for the *conservation* of the spherical Figure, if not the Cause of its putting on that form at the first.

The Doctrine of the Antipodes seem'd a downright contradiction to the Ancients, and their Conceptions concerning such Inhabitants were similar to what might be reasonably expected from Children.

Dr. Hakewell, in his Declaration of the Power and Providence of God in the Government of the World, Book 3d. chap. 8. p. 248. when speaking of the Ignorance of the Ancients relating to their Cosmography, says, "that which

"to me seemeth more strange is, that those

"two

“ two learned Clerks, Lactantius, and Augustine, should with that earnestness deny the *Being* of any Antipodes. Their Words are worth the noting, thereby to see their confidence and eagerness in the maintenance of so evident a mistake. Lactantius saith, “ What shall we think of those who give out there are Antipodes, that walk opposite to us? Do they speak any thing to the purpose; or is there any so blockish as to believe there are Men whose feet are higher than their heads; or that those things there hang, which, with us, lie upon the ground; and that Plants and Trees spring downwards; that the Snow, Rain, and Hail fall upwards upon the Earth; and need any Man to marvel that hanging Gardens are accounted among the seven Wonders of the World, since Philosophers have made both Fields and Seas, Cities and Mountains all hanging?”

Lactantius is here seconded by Augustine, who saith, “ Their Fable of Antipodes, Men dwelling on the opposite part of the Earth, where the Sun rises when it sets to us, having their Feet opposite to ours, is a matter altogether incredible, and by no means to be believ’d.”

“ Zachary, Bishop of Rome, and Boniface, Bishop of Mentz, led (as it were) by the Authority of these Fathers, went farther herein, condemning one Virgilius, Bishop of Saltzburg, as an heretic, only for *holding* that there were Antipodes. But Time and Travel (saith

Dr.

" Dr. Hakewell) have discover'd the contrary  
 " so evidently, that we may as well doubt of  
 " the being of a Sun in the Firmament, as of  
 " the experimental clearness of this Truth."

B. What other general Conclusions do electrical Philosophers draw from the doctrine of falling Bodies?

A. That there is an universal and a violent pressure on the surface of the Earth. — That the pressure must necessarily be universal, since Bodies fall with equal freedom from every part of the surface, consequently the same cause is every where present, and will necessarily produce the same Effect. This, therefore, they conclude to be the physical Cause of the mutual gravitating tendency of all Bodies towards each other, and towards the Centre of the Earth.

B. According to this Doctrine, all things that have hitherto been accounted for by Attraction, you attribute to pressure or to pulsion; but I am persuaded you will find yourself mistaken, particularly, in one thing that I shall mention, which is, the Doctrine of the Tides, or the flux and reflux of the Waters of the Sea, particularly the former, which surely can never be accounted for by an universal pressure: It would seem very strange indeed, if an universal pressure on the surface of the Sea should cause it to rise in Tides.

A. I have so *thoroughly* considered and examined the doctrine of falling Bodies, and an  
 universal



universal pressure on the surface of the Earth, that I can venture to say, if there is any one thing which was usually attributed to Attraction that cannot now be more rationally accounted for by means of an universal pressure, I shall think that one thing alone sufficient to overthrow the doctrine, which I have adopted of an universal Plenum throughout the mundane System, and will readily give it up. — As for the doctrine of the Tides, I must own, I never consider'd them so far as to attempt a Theory of them; however, were I to undertake it, I am persuaded, I could account for them by means of an universal pressure or pulsion, in a much more rational and satisfactory manner than ever it was possible to be done by Attraction.

*B.* Methinks I should be glad of your further explanation of your Sentiments upon this subject.

*A.* In order thereto, I must premise two things by way of Lemma. First, the universality of Æther, or subtile Medium. Secondly, that the Tides are influenced by the presence of the Moon.

*First,* As to the Universality of Æther, it appears sufficiently evident from what has been said above on the doctrine of falling Bodies.

*Secondly,* As to the general appearance of the Tides or rising of the Ocean being influenced by the Moon, that is too well known to be disputed.

In

In the annex'd Figure, let A, B, C, D, represent the utmost Bounds of the solar System; *a, b, c, d, e, f*, the Surface of the Earth; E, its Centre; and M, the Body of the Moon.

If then the surface of the Globe were cover'd with Waters, it would be equally compressed on all Sides, and no Tide would happen were not some large Body near to it; but by means of the interposition of the Body of the Moon, the same equal pressure must be interrupted at that part of the Earth at *a*, which is nearest to M, consequently the yielding Waters would naturally flow to the part *a*, which is the least pressed, that is to *b, a, f*, highest at *a*. — It is manifest, that in this Case there would be but one Tide at any particular place every 24 hours nearly, since the same protuberance or swell of the yielding Waters would accompany the Moon all round the Earth, and would then be exact and regular, and not interrupted, as it now is by the Land, by Capes, and Promontories, &c.

But as there are two Tides instead of one, so no one doubts of their being caused by the Influence of the two Luminaries; but the greatest difficulty appears to be the following, viz. that notwithstanding their Position and Distance from each other, which though continually varying, yet the difference of the two Tides relating to time is nearly equal; this, however, is a difficulty common to all Theories of the Tides: But as I observ'd, I had  
never

never attempted to write a Theory of them, so shall only add a general hint to shew you what would be the consequence of such an universal pressure, when view'd in a proper light.

## DIALOGUE. VII.

*Fundamental Principles.—That the fix'd Stars are Suns in the Centres of so many Salar Systems ——— The grand Objection answered, or rather the fallacious Question to prove a Vacuum refuted by means of an easy Experiment.*

### Fundamental Principles.

**B.**  **H A T** are the first and fundamental Principles of Electrical Philosophy?

**A.** *First*, That the whole System of Nature is replete with ætherial or pure elementary Fire, i. e. the same pure Fire which we have discovered by means of the electrical Apparatus, and which is so exceedingly pure, that, like the solar Fire in the Focus of a Burning Glass or concave Speculum, it yields neither smoke, ashes, nor any other gross feculent matter.

**L.** *Secondly*,



*Secondly*, That this universal elastic Fire acts by impulse on all other bodies, and is the sole cause of their centripetal tendency towards the Sun, and of all terrestrial bodies towards the Earth.

*Thirdly*, That the Elements are in strictness no more than two, viz. Fire, and gross Matter, the one active, and the other passive.

*Fourthly*, That the fixed Stars are Suns, in the Centres of so many solar Systems, each of them encompassed with their revolving Planets, primary and secondary, like our own.

*Fifthly*, That the Operations of Nature are perform'd mechanically, i. e. by means of material or secondary Causes.

*Sixthly*, That the pure, primary Air, Æther, or fluid Matter of the Heavens is indefinitely rare and indefinitely elastic, according to Sir Isaac Newton's Definition in his Optics — Quer. 21.

*Seventhly*, That it is universal and expanded through all the Heavens — Quer. 18.

*Eighthly*, That this universal Principle exists not only in all open spaces, but in all the minutest pores and vacuities of the most dense and compacted Bodies.

*B.* What Authority have you for such a Plurality of solar Systems; has it not something of a romantic appearance?

*A.* So far from it, that the doctrine of such a plurality of solar Systems is universally receiv'd by modern Astronomers, and seems to have the best pretensions to truth. The

The ingenious Dr. Derham, in his Astro-Theology, Book 2d. chap. 2d. observes, "that  
 "from the parity and constant uniformity ob-  
 "servable in all God's Works, we have great  
 "Reason to conclude, that every fixt Star hath  
 "a System of Planets as well as the Sun. For  
 "it is certain, that the Sun is a fixt Star to the  
 "fixt Stars, as they are to the Sun. And in this  
 "case, *if*, (as the justly renown'd Mr. Christian  
 Huygens argues) *(a)* we should imagine ourselves  
 to be placed somewhere in the heavenly Regions,  
 as far from the Sun as from the fixt Stars, we  
 should then perceive no difference between the one  
 and the other. For it would be very unlikely,  
 that we should see any of the solar Planets, either  
 by reason of the diminishing of their light, or be-  
 cause their Orbs would sink into the same lucid  
 point with that of the Sun. Being then so placed,  
 we should imagine all these Stars [both Sun and  
 fixt Stars] to be much of the same nature and  
 kind; and from a view of any one of them nearer  
 to us than the rest, we should make our judge-  
 ment of them all. And now being, saith he, by  
 the Favour of God, admitted so near one of them,  
 namely, the Sun, as to see six lesser Globes revol-  
 ving round about him, and other secondary ones  
 revolving round some of them; why ought we  
 not to have the same judgement of the rest of  
 those Suns as of this, and think it altogether  
 probable, that this is not the only Star, of all the

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(a) See his Cosmotheorus.

number that is encompassed with such a train, or in any respect excels the rest? Neither also that this Star alone revolves round its own axis, but rather, that all the rest have somewhat of the same kind also.

“And so that learned Person goes on in further pursuit of this ingenious Argument.”

“Besides those strong probabilities, we have this farther to recommend those imaginations to us, that this account of the Universe is far more magnificent, worthy of, and becoming the Infinite Creator than any other of the narrower Schemes. For here we have the Works of the Creation, not confin’d to the more scanty Limits of the Orb, or Arch of the fixt Stars, or even the larger Space of the *primum mobile*, which the Ancients fancied were the utmost Bounds of the Universe) but they are extended to far larger, as well as more probable, even an indefinite Space. Also in this prospect of the Creation, as the Earth is discarded from being the Centre of the Universe, so neither do we make the Uses and Offices of all the glorious Bodies of the Universe to center therein; nay in Man alone, according to the old vulgar opinion, that all things were made for *Man*. But in this our Scheme, we have a far more extensive, grand, and noble view of God’s Works, a far greater number of them; not those alone that former Ages saw, but multitudes of others that the Telescope has discover’d

“since;



“ since; and all these far more orderly placed  
 “ through the Heavens, and at more due and  
 “ agreeable distances, and made to serve to much  
 “ more noble and proper ends; for here we  
 “ have not one System of Sun and Planets alone,  
 “ and one only habitable Globe; but myriads  
 “ of Systems, and more of habitable Worlds,  
 “ and some even in our own solar System, as  
 “ well as those of fixt Stars. And consequently,  
 “ if in the Sun and its Planets, although view’d  
 “ here upon Earth at a great distance, we find  
 “ enough to entertain our Eye, to captivate  
 “ our Understanding, to excite our Admira-  
 “ tion and Praises of the Infinite Creator and  
 “ Contriver of them: What an augmentation  
 “ of these Glories shall we find in great mul-  
 “ titudes of them, and in all those Systems  
 “ of the fixt Stars through the Universe, that  
 “ I have spoken of!”  
 “ Book 6th. chap. 1st. After taking notice  
 “ of the spherical Figure of the Earth and of  
 “ Gravity,” he saith, “ leaving all conjectural  
 “ matters, let us come to a more evident be-  
 “ nefit of Gravity, and that is, the natural  
 “ tendency of all Bodies to the Centre of the  
 “ Globe; this is very manifest in our own  
 “ Globe. For whatsoever the Decays are  
 “ among earthly things; however their Forms  
 “ are changed; yet their matter remains entire,  
 “ and returns again to its grand Parent the  
 “ Earth, and adds, an admirable Provision  
 “ Gravity is for the perpetuity of the Globe,  
 “ and

“ and to continue the state and habitability  
 “ thereof throughout all Ages, which would  
 “ otherwise waste or decay, or run into the  
 “ most irreparable and pernicious Disorders.”

The same Author proceeds in his 2d. Chap. to shew the great Benefit afforded by Gravity against the centrifugal Force of the several Parts of the Planets. “ Upon a supposition,” he says, “ That every one of the Globes revolves round its Axis, we shall find besides  
 “ the Benefits already specified, another very  
 “ great use of *Gravity*, to the good, yea, to  
 “ the very Existence of our own and other  
 “ Globes, and that is, the preservation of their  
 “ integrity against the centrifugal Force of their  
 “ Revolution or diurnal Motion.”

“ For without such a band as Gravity to  
 “ keep their Parts together, the whirling about  
 “ of those Globes would shatter them in pieces  
 “ and dissipate them abroad into the circum-  
 “ ambient Space. Thus must it needs befall our  
 “ own Globe, which whirls about at the rate  
 “ of above 1000 Miles an hour, and is com-  
 “ posed of Earth and Water, materials of much  
 “ too loose a texture to prevent the dissipation  
 “ which the centrifugal Force of such a rota-  
 “ tion must necessarily occasion about the  
 “ equatorial parts; a rotation that would as  
 “ easily throw off the parts of the Earth, espe-  
 “ cially the Waters, as the whirling round of a  
 “ Wheel or Globe would the loose dust lodg’d  
 “ upon it.”

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“ A little farther on he takes notice of the  
 “ centrifugal Force of the planet Jupiter, which  
 “ by means of its extraordinary bulk, and  
 “ performing its rotation on its Axis in less  
 “ than ten Hours, is, as he says at the rate of  
 “ 38159 Miles an hour at its Equator, and  
 “ therefore in imminent danger of being whirl'd  
 “ in pieces by so rapid a Motion, were not its  
 “ parts kept close together by such a band as  
 “ Gravity.”

“ This Gravity of Bodies is observ'd mani-  
 “ festly to decrease in proportion of the square  
 “ of their distances reciprocally, that is, at  
 “ twice their distance, the Force is but one  
 “ fourth of what it was at a single distance ;  
 “ and but a ninth at thrice their distance, &c.”

Dr. Derham's Astro-Theology, p. 100. Ed. 9.

Mr. Harvey, in his Contemplations on the  
 Starry Heavens, after treating of the Sun, adds,  
 “ This Sun, with all its attendant Planets is  
 “ but a very little part of the grand Machine  
 “ of the Universe. Every Star, though in ap-  
 “ pearance no bigger than the Diamond that  
 “ glitters on a Lady's Ring, is really a vast  
 “ Globe, like the Sun in size and in glory ;  
 “ no less spacious, no less luminous than the  
 “ radiant source of our Day. So that every  
 “ Star is not barely a World, but the Centre  
 “ of a magnificent System, has a retinue of  
 “ Worlds irradiated by its Beams, and revolv-  
 “ ing round its attractive Influence. All which  
 “ are lost to our Sight in immeasurable Wilds

“ of



“ of *Aether*. — That the Stars appear like so  
 “ many diminutive and scarce distinguishable  
 “ Points, is owing to their immense and incon-  
 “ ceivable distance. Immense and inconceiv-  
 “ able indeed ! since a Ball shot from the  
 “ loaded Cannon and flying with un-abated  
 “ rapidity must travel, at this impetuous rate,  
 “ almost seven hundred thousand Years before  
 “ it could reach the nearest of those twinkling  
 “ Luminaries.”

*B.* This is most wonderful indeed ! But surely the receiv'd Maxim of Philosophers is contradicted thereby, viz. that the Works of Nature in every individual part, like the most perfect mechanical Machine, mutually assist, and are subservient to each other, which in this Case seems incredible ; for of what use can such an infinite Number of Solar Systems be to each other, or to us, when the nearest of them is at such an immense distance ?

*A.* By means of a plurality of Solar Systems is afforded such a rational method to account for the material Cause of Gravity in the celestial Regions as was never known, nor perhaps, ever thought of before ; yet this must be allow'd, unless a more rational and satisfactory method can be thought of than that of my Theory of the Nature and Office of the Sun ; since according to that, the centripetal or gravitating tendency of the heavenly Bodies is accounted for in a rational and natural manner, particularly at p. 237. of the Essays.

*B.*

*B.* I should be exceedingly well pleased with a Recapitulation of that Theory; for indeed to say the Truth I have forgotten it.

*A.* I shall think no Recapitulation troublesome that can contribute towards your Improvement; and the rather, because it will be necessary in the present Case to obtain a clear Idea of our Sun and System before the Nature and Office of the rest of them can be pointed out; but of that Recapitulation farther on when I come to treat of the Cause of Gravity in general.

*B.* Of all these fundamental Principles, none is so strenuously opposed as the very first, that of an universal Plenum. If such a Principle be but mention'd, it is sure to be rejected as fabulous.

The maintainers of the established Philosophy affirm, that were there not an universal Vacuum, there could be no such thing as Motion; for supposing an universal Plenum, instead of an undecaying motion of the Planetary Bodies, it must be absolutely impossible for them to move at all, unless two Bodies could exist in one and the same identical space, which is allowed to be the greatest Absurdity.

*A.* In Answer to this grand Objection, I shall cite a Passage from that celebrated Writer, the Rev. Mr. Jones, frequently mentioned in my Essays, who having in the 4th chap. of the 1st Book, p. 29. of his Essay on the first Principles of Natural Philosophy, been treating of

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the *vis inertiae*, proceeds in the former part of his 5th chap. p. 39. in the following manner.

“ Thus much, I think, may suffice to shew,  
“ that the celebrated Demonstration of a *Va-*  
“ *cuum* has *set out* wrong. It will be as easy  
“ to prove, even waving all that has been said  
“ on the *vis inertiae*, that it has *concluded*  
“ wrong; if the *relation between a moving body*  
“ *and a resisting medium* be rightly understood.”

“ When a Pendulum is made to swing in  
“ *Air, Water, or Mercury*, the resistance it  
“ meets with is greater, as the medium is  
“ denser: and as a Plenum of *Æther*, such  
“ as the mechanical Philosophy requires, would  
“ be more dense than any other Fluid, its  
“ Resistance, they say, must be greater: no  
“ Motion could possibly continue in it. But  
“ then as motion is observed to continue in the  
“ Heavens, without any *sensible Diminution*,  
“ there can be no Resistance in the heavenly  
“ Spaces, and consequently no matter of suffi-  
“ cient density to occasion it.

“ This was Sir *Isaac Newton*’s way of com-  
“ puting Resistances, and the use he made of  
“ them when computed. That we may see  
“ whether this Doctrine agrees with Expe-  
“ rience, let us suppose a Ship, with its Sails  
“ spread, to be in motion before the Wind;  
“ every Body must allow me, that if the Wind  
“ were to keep its direction, and the Ship to  
“ have an open Sea, it would go quite round  
“ the Globe; and for the same Reason that it

“ makes



" makes one Revolution, it would make ano-  
 " ther, and so on *ad infinitum*. Are we to say,  
 " that the *Air*, in which it moves, is an *unresist-*  
 " *ing Medium*? We ought to say this, if the  
 " Demonstration above-mentioned really is  
 " what it pretends to be. But the truth is, a  
 " Medium may, *in its nature*, be a resisting  
 " one, and yet *in fact* give no such Resist-  
 " ance, as shall be any Impediment to a Body  
 " moving in it. For let any Person tell me,  
 " how much Resistance the Ship receives from  
 " the *Air* in this case? The Answer must be,  
 " ——— less than none: the Resistance here is  
 " a negative quantity; and the Ship is so far  
 " from *losing* its Motion, that it is continually  
 " *receiving* it, as it passes through the *Air*;  
 " yet it would be false to affirm of *Air* in ge-  
 " neral, that it is not a resisting Medium. As  
 " to the *Water* the Ship sails upon, this being  
 " not the *cause* of its motion, will serve to  
 " retard it; but as the continued impulse of the  
 " *Air* behind, is superior to the sum of all the  
 " following Resistances, 1<sup>st</sup>, of the *Air before*,  
 " 2<sup>dly</sup>, of the *Water* the Ship sails upon, and  
 " 3<sup>dly</sup>, of the *Cause of Gravity* which is con-  
 " tinually acting upon it; the motion will  
 " continue notwithstanding these Impediments.  
 " Were it to be laid down as a general rule  
 " from this particular instance, that *Water* re-  
 " sists Motion, but *Air* does not; neither will  
 " this coincide with Experience. A Cork, or  
 " any other light Body, thrown upon the  
 " stream

“ stream of a sluice or floodgate, will be carried  
“ off with it; and as it is common for a con-  
“ siderable part of the Water to return again  
“ upon the stream in a curve, if it be obstruct-  
“ ed by the banks, and have but a narrow  
“ outlet, the Cork may come about with it,  
“ and compleat its Revolutions, so long as the  
“ cause continues to act upon it. The Water  
“ gives no more Resistance in this case, than  
“ the Air did in the other: and thus it will  
“ happen universally, that every fluid, where  
“ it is the *Cause of Motion*, will not be found  
“ in that case to give any *Resistance*, be its  
“ quantity of matter great or small.”  
“ We are now prepared to return to the  
“ Pendulum. If it vibrates in *Air*, the Air will  
“ retard its motion; and there is a good rea-  
“ son why it should do so, for Air is not the  
“ *Cause of its Motion*. If in *Water*, neither  
“ is that the cause of its motion; and it will  
“ give a greater Resistance to it in proportion  
“ to its quantity of matter, that is, in propor-  
“ tion to the action of Gravity upon it. If in  
“ *Quicksilver*, it will meet with a still greater  
“ Resistance, for the same reasons. But if  
“ there be any elementary *Æther*, acting as  
“ the natural *Cause of Gravity* in Bodies; it is  
“ just as absurd, to search for the Resistance  
“ of *such a fluid*, from the motion of a *falling*  
“ *Body*; as for that of the *Air*, from the mo-  
“ tion of a Ship that sails by it; or for that  
“ of Water, from the motion of bodies carried  
“ down

down by a current of it. If one Philosopher  
 may conclude, that Gravity cannot be owing  
 to any material fluid, because he has  
 found, that this fluid does not resist a gravitating Body; may not another demonstrate  
 with equal truth, that a Ship cannot sail by  
 the action of the Air upon it, because he  
 finds, from the nicest observations, that the  
 Air does not deprive it of its Motion?"

Lest the Reader should have suspected me  
 of a design to prejudice him beforehand,  
 and to inject scruples through a want of better  
 Arguments; I did not observe at the  
 beginning of this disquisition, that Sir Isaac  
 had drawn two opposite Conclusions from a  
 capital Experiment, relating to the affair  
 now before us, but it will be proper just to  
 mention it in this place. Having caused an  
 empty wooden Box to vibrate as a Pendulum,  
 he loaded the same Box with 77 times its own  
 weight of metal; and in this latter case  
 found the motion to be retarded more than  
 it ought to have been by the Theory. In  
 two different Editions of his Philosophy, he  
 imputes this to two different causes, without  
 the least hint or apology to his Readers for  
 such an important change in his Opinion.  
 In that of 1687 he accounts for this, from  
 an increase in the Resistance of the Air, occasioned  
 by a swifter motion in the heavier Pendulum;  
 and has demonstrated elsewhere, that the Resistance of a Fluid to a Body  
 moving



“ moving in it, must increase in a *duplicate*  
 “ *ratio* \* of the body's velocity; but this con-  
 “ sideration hath no place here. In that of  
 “ 1726, he imputes this same effect, without  
 “ any repetition of the Experiment, to the  
 “ resistance of a *subtile medium* against the  
 “ solid parts of the inclosed metal; and men-  
 “ tions not a word about the *Resistance of the*  
 “ *Air*. But herein, it seems, he corrected his  
 “ Philosophy not for the better, it being ab-  
 “ surd, that the resistance of a *subtil Æther*  
 “ should be discovered in such a case as this. ”  
 “ This great Man seems to have laid it  
 “ down as the foundation of these conjectures  
 “ (for I hope they are not both *Demonstrations*)  
 “ that an Experiment, which requires machi-  
 “ nery, can be performed absolutely without  
 “ Friction; the contrary to which is well  
 “ known to every Mechanic. It is reasonable  
 “ to think therefore that the Friction between  
 “ the hook and ring, on which his Pendulum  
 “ swung, must have been somewhat increased,  
 “ when the Ball was loaded with a weight 77  
 “ times greater; and the difference he found,  
 “ was no greater than might arise from such  
 “ an Impediment, though the Instrument were

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\* “ The Resistance a Body meets with from a Medium,  
 “ is as the Velocity of the Body, and the Space of the Me-  
 “ dium passed through by it, multiplied into each other.  
 “ But that Space will always be as the Velocity; therefore  
 “ the Resistance is, as the Velocity multiplied into itself,  
 “ that is, as the *Square of the Velocity*. ”

“ ever so perfect. It is hard to say, how a Man  
 “ of Genius, as he certainly was, could throw  
 “ a plain Experiment into two such different  
 “ Shapes, neither of which are agreeable to  
 “ Reason. Perhaps he thought it would suit bet-  
 “ ter with the Principles he was endeavouring to  
 “ establish, not altogether to deny the existence  
 “ of a subtil Æther, as he did at first, for that  
 “ would have been too much ; but rather to  
 “ ensure his Philosophy, and keep this Æther  
 “ from breaking in upon his System, by im-  
 “ puting to it a degree of *Resistance*. Whether  
 “ the learned will consider of these things, I  
 “ cannot pretend to judge ; in time perhaps  
 “ they may : but for a while, I presume, he  
 “ that ventures to interpose, must be content  
 “ to let the reproach fall upon himself. There  
 “ was a time when Men had given up their  
 “ Understandings to the Logic of the Schools  
 “ † and the Quirks of *Aristotle* ; and woe was

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† “ I will give a Specimen of their manner pertinent to  
 “ the Subject we are upon. It is a logical demonstration of a  
 “ Vacuum, extracted from Lib. 4. c. 6. of *Aristotle's* Physics.  
 “ If there be no Vacuum, there can be no Loco-motion. For a  
 “ space already full cannot receive any thing into it ; if it did,  
 “ there would be two Bodies in the same place ; which is an absurdi-  
 “ ty. Some of his Commentators put it thus — probatur  
 “ assumptio ; quia corpus quod locum mutat, vel inani spatio  
 “ excipitur, vel pleno : si inani, habetur propositum : si  
 “ pleno, sequitur duo corpora sese permeare — The assumption  
 “ is thus proved ; because a Body that changes its place, is received  
 “ either into a space Full of matter, or into one that is Empty :  
 “ If into an empty space, the point is proved ; if into a full space,  
 “ then it follows that two Bodies must penetrate one another's di-  
 “ mensions. And *Aristotle* tells us of one *Melissus*, an antient  
 “ to

“ to the Man, who dared to publish a suspicion  
 “ against them. That fashion is now exploded,  
 “ and we are all enslaved to the pretences of a  
 “ *mathematic* Certainty. But if the Doctrine  
 “ of a Vacuum is really weak and without  
 “ foundation, this fashion will have its period  
 “ like the former, and we shall be restored  
 “ again to the enjoyment of our philosophical  
 “ Rights and Liberties.”

Thus you see how even many ingenious and  
 learned Men delude themselves by embracing  
 the mistaken and fallacious Arguments of others  
 without examining them.

“ sophist, who being reduced to the last extremity by the  
 “ Force of this miserable argument and determined not to  
 “ admit a *Vacuum*, denied the reality of motion, and held  
 “ the Universe to be immoveable. Had this Philosopher  
 “ trusted to Experiments instead of Logic, he might have  
 “ silenced his adversaries with very little trouble. For if a  
 “ Bullet be put into a Bottle quite full of Water, and close  
 “ stopp’d down, we have a space filled with an *incompressible*  
 “ *Fluid*; which constitutes as good a Plenum as need be  
 “ desired; yet upon inverting the Bottle, we find the Bullet  
 “ can move from the Top to the Bottom, or from one side  
 “ to the other, as freely as if the Bottle were empty. Does  
 “ it move into an empty space, or into a full one? Why  
 “ truly, into neither; for the Bullet and the Fluid *change*  
 “ *places* with one another, so that the Motion is not hindered,  
 “ though the space is always full of Matter.”



## DIALOGUE. VIII.

*Of the Pneuma. — Of two electrical Æthers. — The manner in which the gilded Phial or the gilded Saffpane is charged, and of positive and negative Electricity. — The Leyden Experiment investigated.*

B. \*\*\* H A T am I next to consider?

\*\*\* W \*\*\* A. One thing more seems necessary to be known by every electrical Philosopher in order to render Experiments more plain and intelligible, which is, that in a variety of Experiments, there are effects that seem as widely different from what are observ'd in common, as if they proceeded from two different Agents; probably, the effects are different Phenomena produc'd by the same Agent, acting in different forms; since they seem not independent of each other, but co-existent: the one part appears from the effects to be much more subtile and active than the other: the one seems incapable of penetrating a glass body while replete with Air; the other pervades it at the same time with the greatest freedom, acting on small bodies within side of the glass as if nothing were between them: the more subtile active part called *Pneuma*, or Spirit of Æther, is an

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appellation, borrowed from the renowned Lord Bacon, as you will find in the 6th chap. of my Essays, where that great Author treats at large of Spirits and Pneumatics. In that and the chap. following are many Experiments which illustrate and confirm the reality of such an active Pneuma, or Spirit; the knowledge of which is another valuable guiding clue, not only to the solution of many electrical Experiments, but to other abstruse Phenomena of Nature, which are otherwise inexplicable; and therefore well worthy of our Investigation.

Many Electricians from Observations and Appearances of the like nature have been of Opinion, that there were really two different and distinct electrical fluids, as appears from Dr. Priestley's History——“It had hitherto” he says, “been universally supposed, that all the Phenomena of Electricity were produced by the action of one electrical fluid.” Mr. Du Fay however imagined he had discovered another electrical fluid distinct from that of Glass, and peculiar to that of Resin, &c. and thought that it was quite independent of the other, and that their operations were never combin'd. Mr. Symmer exhibits a variety of curious Experiments, relating to the same subject, and infers from them the probable existence of two electrical fluids; not independent, but always co-existent and counteracting one another.

The Abbé Noller seems not to be of the Opinion that two such Æthers exist; but main-  
tains

tains two contrary currents of the same fluid continued, and (to use his own Terms) concludes that a *simultaneous effluence and affluence of a fluid matter, extremely subtile, constitutes Electricity.*

Is not the Opinion of two different subtile Mediums or Æthers like straying too wide from simple Nature, and consequently too unphilosophical to be admitted? Does not such an universal subtile Æther as we have just discover'd seem abundantly sufficient to solve the Phenomena, particularly when we consider it as endued with various affections, qualities, and properties, acting in different capacities, conditions and forms? This Doctrine is likewise agreeable to Sir Isaac Newton's first Rule of Reasoning in Philosophy, viz. *We must admit no more Causes of natural things than what are true and sufficient to explain their Appearances; Nature being pleas'd with simplicity, and affects not the Pomp of superfluous Causes.*

I say, do not two such universal subtile Mediums look too much unlike simple Nature to be admitted? Is it not more rational to suppose, that what are thought to be effects of another electrical fluid, are produced, by so many appendants, as it were, and in fact nothing more than as before observ'd, the same Agent acting in different capacities, different forms and modes, and in different circumstances? — What we term positive and negative Electricity is by no means a sufficient proof of



two electrical fluids, they seem only different modes of the same universal Agent.

B. I cannot say I am very well acquainted with the Term negative Electricity: I should therefore be glad to be better inform'd concerning it.

A. To render it as plain and obvious as possible, I shall be here obliged, for more reasons than one, to transcribe the greatest part of the 11th chap. of my Essays, part the 1st; where you will find the manner that the Sash-pane, and the Glass Receiver or Leyden Phial are charg'd; which will help to convey an Idea of what is meant by negative Electricity; and is as follows.

“*First*, Let A, and B, represent two Persons, and let A be electrified on the Resin-cake, while B is only on the floor.”

“*Secondly*, Let a Sash-pane properly gilded on both sides be held between them with its plane in a perpendicular position, and the edge of it towards each Person, that so the two sides of the Pane may the more easily be view'd at once.”

“*Thirdly*, If each Person approach a different surface of the Pane with a Finger at nearly equal distances, when they are about half an inch from the surface, a spark will dart from the Finger of each to the Glass. — This is perform'd so instantaneously, as to appear as one single spark, i. e. from the electrified finger of A through the thin Glass to the unelectrified finger

finger of B; but the effect shews the contrary:

For were that the case, the Pane would not be affected thereby, whereas a few of those operations charge it. It will as plainly appear that the Phial is charged the same way. For if a Phial be set on an electric Cake, and A and B approach it with their fingers, the one near the Cork-wire, and the other near the coating, when they are at the proper distance, sparks will dart from each finger at the same instant, and the Phial will be charged as the Pane was before."

But what is most remarkable is, that though it be found necessary to electrify both sides of the Pane or Phial before, it will produce the desired effect; yet if both sides are electrified from the Machine, or from *two* different Machines, it is of no more effect than if only one side of it were electrified."

"The most commodious way of managing the Phial is to take it in the hand, for by that means the Experiments will be more easily made, and the Effects more visible, than when it hangs on the prime Conductor, and consequently may be explained in a more easy and familiar manner; for A being electrified, his hand which holds the Phial is, with regard to the Phial, the prime Conductor, not only when he holds it by the Cork-wire, and by that means electrifies the inside; but if instead of that he holds it by the coating, that only will be electrified. — First then, if he take it by the

the Cork-wire, it will be in the same situation as the gilded Sash-pane was, when A laid a finger on one side only, that is, since he will not be convulsed by bringing his other hand to the coating; but if he remove that hand from the coating, and B on the floor lay on his hand or finger on the coating, it will soon be sufficiently charged; for if after that A lay his finger to it again, he will then be shock'd as usual. — The same effect will follow, if instead of holding the Phial by the wire, he take it by the coating, and hold it ever so long in his hand, the coating only will be electrified; for if after that he bring his finger to the wire, he feels nothing; but if B, standing on the floor, lay on his finger, the Phial is then very soon compleatly charged. For if A put his finger to it again, he is then convulsed. So that in either case, the Phial according to Dr. *Franklin*, was electrified *plus* and *minus*, i. e. first, when A held it by the Cork-wire, the inside was electrified *plus*, and the coating *minus*; and secondly, when he grasped it by the coating, that was electrified *plus*, and the inside *minus*, or in a state of want: In either case the Phial could never be charg'd, till the other surface of it was furnish'd from the hand of B on the floor."

" In like manner if B on the floor takes the Phial into his hand, either by the Cork-wire or by the coating, the same effects will follow: If by the coating, the inside will be electrified if A lay a finger on the wire; for after this B  
will



will receive the shock, if he bring his other hand to the wire; and the same effect will be produced, if instead of his holding it by the coating, he should hold it by the wire; for then A electrifies the coating by laying his finger on that."

"Hence the similarity of the Phial, and gilded Sash-pane; from either of which, a Phenomenon is exhibited, which perhaps was hardly thought of before, namely, that when the glass Receiver is properly charged, one side of it is actually electrified immediately from the Earth, thro' the Chain or other non-electrical Body communicating with it. — Is not this a plain Intimation that the electrical fluid, which is produced from the Earth is in a negative state, since that is the state of the coating of a charg'd Phial, viz. that side of it which communicates with the Earth at the time of charging it, whether it be the inside or the outside."

Hence it may be safely concluded, that the Electricity, as it is called, i. e. the Æther, which is obtain'd immediately from the earth or floor is in a negative state, which may very probably be the natural cause of the Thunder-clouds being for the most part in such a state, as Dr. Franklin observ'd them to be.

The 12th and 13th Letters of his 2d Edition contain a particular account of Electricity, by Experiments made with his iron rod from the top of his House; in most of which it was in

a negative state; sometimes indeed, though but seldom, it was for a small time in a positive state.

The Dr. advances what seems very rational at p. 119. viz. why the Lightning may be *expected* to be in a negative state, viz. "When a portion of Water" he says, "is in its common dense state, it will hold no more electrical Fire than it has. — When the same portion of Water is rarefied into vapour and forms a cloud, it is then capable of receiving and absorbing a much greater quantity; there is room for each particle to have an electric atmosphere." "Thus Water in its rarefied state, or in the form of a Cloud, will be in a negative state of electricity; it will have less than its natural quantity, that is, less than it is naturally capable of attracting and absorbing in that state."

*The manner how the Shock in the Leyden Experiment is generated and propagated.*

Having carefully advanced thus far, on what is presumed will be allowed to be sufficient evidence; since there is nothing either strain'd, fictitious, or arbitrary; no other Properties or Qualities having been ascribed to this Æther than what are plainly discover'd in it, most of which

which were foretold by Sir *Isaac Newton* many Years ago; particularly, first, *that it is much like Air in all respects, but far more subtle.* See his Letter to Mr. *Boyle*. Secondly, *that it lies hid in the pores of all gross Bodies* in the manner foretold in the last paragraph of his *Principia*: And almost all Experiments are on his side and loudly proclaim the same Properties, which are so obvious, that whoever is conversant with them, or will but take the least trouble to inform himself, can neither miss finding such a fluid to exist in the pores of Bodies, nor after he has pumped it out (a) with the electrical Machine, can he easily be ignorant of its inherent Rarity and Elasticity. — I shall endeavour next to investigate the means by which that inconceivable violence is generated in the Leyden Experiment by the same cautious method.

In order to perform so difficult a task, which has hitherto baffled every attempt, I shall here collect some positions, which have been already proved, and try how far they are capable of assisting me in the arduous Undertaking.

*First*, That the constituent parts of *Aether*, contained in Bodies, consist of all degrees of rarity, or rather all degrees of purity, agreeable to the nature of it, as described by Sir *Isaac*

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(a) We know says Dr. Franklin, that the electrical Fluid is in common matter, because we can pump it out by the Globe or Tube. See the 2d. Edit. of his Letters, p. 53.



*Newton* in his forementioned Letter to *Mr. Boyle*.

*Secondly*, That the most pure, rare, and subtile part of it, is also the most elastic and active; and that this rule holds equally true in all the intermediate gradations from the most pure æthereal part, down to the grossest common Air.

*Thirdly*, That the subtile Æther contained in the pores of the most perfect non-electrical Bodies is loose, free, and fluid, as in Metals, Water, Animals, and green Vegetables, especially in the two former; and in various cases, it is found, from the strictest observations, to move freely out, provided it be for an equal quantity of the same fluid to succeed it.

*Fourthly*, That in all degrees of Attrition, a proportionate degree of Expansion is exerted, at least to a certain height; and since the homogeneous particles mutually repel each other, and consequently the masses composed of them, the expansive force therefore of the pure Air or Æther is so much superior to the expansive force of the common Air, that the limits occupied by a mass or assemblage of the former, such as the accumulations on Bodies when electrified, must consequently, by being so much more elastic than the latter, buoy it up, that is, repel and bear it away from the Body on which the Æther is accumulated: By this means the equilibrium is destroyed, and in the same proportion as the rarity of the Æther within those limits

limits exceeds that of the common Air, which surrounds it; and consequently that those rare limits may be consider'd as similar to a temporary Vacuum with respect to the Air, especially since the effects of almost all electrical Experiments verify the facts, and therefore justify the conclusion.

*Fifthly*, That the *Æther* is firmly fixed in all the parts of Amber, Glass, Resin, Wax, and all other Bodies, term'd original Electrics. See Sect. 204.

*Sixthly*, That when those subtile particles are irritated by attrition or friction of any kind (which is the case when the Glass is rubbed, since by being fixed in all parts of the Glass it is incapable of escaping from the Instrument of friction) we can always observe from the effects of every such Experiment, that the Equilibrium of the adjacent Air is destroy'd, and that the forementioned *Pneuma* or *Spirit* is incessantly passing into such rarefied limits from all the surrounding parts and by that means impel light Bodies into them (*a*).

A small Attrition of the Glass or a piece of good Amber is sufficient to produce those ef-

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(*a*) From the effects of the Experiments, those Limits appear to be the most rare and elastic of all, at the very surface of the electrified Body, whether it be the rubb'd Glass, or whether it be any other thing electrified; and that from the surface of the electrified Body to the extremity of those Limits, such rarity and elasticity gradually decrease; the included *Æther* becoming more and more gross, from the Body on which it is accumulated,

fects, as appears from Mr. Boyle's Experiment with a piece of amber when only laid in the Sun, or even a Glass warmed by the fire, which by that means became electrical. See Vol. I. p. 400. of Mr. Boyle's Works, abridged by Mr. Shaw.

If then so inconsiderable an Attrition as the Sun's Beams striking on the surface of those Bodies where the *Æther* is fix'd, be yet sufficient to cause such an emanation, or as he terms it, effluvia emitted by the Glass, we have the less room to admire, if the same emanation be extended to a much greater distance from the Glass when the *Æther* at the surface of it is irritated by violent friction. — But the effects of those *effluvia* or emanations extended from the fix'd *Æther* in the Glass, are not only visible on the rubb'd side of the Glass, but extend themselves quite through it, if it be not too thick; for if a pane of Glass be held over light Bodies and rubb'd, the equilibrium is destroyed on the under surface, as is found by the effect, those light Bodies being impelled towards it in the same manner as to the rubb'd side: When the friction at the surface of the Glass ceases, the same elastic and rare emanation soon shrinks back again to the Origin from whence it came.

*Seventhly*, Attrition on the surface of Glass was the only way that was known of electrifying it, till another was accidentally discovered to Professor *Muschenbroek*, viz. that of confining a thin Glass between two dense non-electrics,



tries, and then electrifying one of them by suffering it to communicate with the excited Apparatus, where the effects are very remarkable; for no sooner is the prime Conductor, &c. electrified, but that surface of the Glass which communicates with it is electrified also, at which time the subtilest and most elastic part instantly pervades the thin Glass, and there impels, buoys up, or bears off the common Air, and rare Limits are form'd on that surface likewise, as we find by the effects; and light bodies are as forcibly impell'd to that surface as to the other.

And to that most rarefied surface the Spirit or Pneuma sets in from the Earth, thro' dense non-electrics so freely, that the Glass soon becomes sufficiently charged; that is, It is then what Dr. *Franklin* calls "electrified in the common way."

"When a Bottle," he says, "is charged in the common way, its inside and outside surfaces stand ready, the one to give fire by the hook, the other to receive it by the coating; the one is full and ready to throw out, the other empty and extremely hungry; yet as, the first will not give out, unless the other can at the same instant receive in; so neither will the latter receive in, unless the first can at the same instant give out. When both can be done at once, 'tis effected with inconceivable quickness and violence.

Or in other words, the inside furniture of the Phial having a property of retaining the Æther obtained

obtained from the Machine, that surface is, according to Dr. *Franklin*, electrified *positively* on account of its being there more strongly retain'd than by any other means; and the coating is for the same reason electrified *negatively* in as high a degree, which surface he terms extremely hungry: When these two surfaces are in this state, and a non-electrical Circuit completed from the one to the other, the Equilibrium is instantly restored at both, and with inconceivable violence.

The *plenum* at the one surface electrified by the Machine escapes into the *vacuum* at the other, i. e. the redundancy on one is discharg'd on the other, which the Dr. terms so extremely hungry, and thus the equilibrium is instantly restored at both, thro' the non-electric Circuit, with the utmost violence, whether it be long or short, regular or irregular, or with ever so many turnings and windings.

The sudden and violent shock is propagated throughout the non-electric Circuit by means of the continuity of the particles of the *Æther* contain'd in it, from one end to the other; and notwithstanding the irregularity of the Circuit, yet the contain'd *Æther* is mov'd in a similar manner and with the same freedom as every part of the Circumference of a solid Circle or Wheel is conceiv'd to be moved, were such Wheel to be turned on its Axis; for otherwise it would be difficult to imagine how a motion could be communicated to every part of the largest Circuit possible, as instantaneously as to the smallest.

Dialogue

## DIALOGUE. IX.

*A Definition of a complete Sceptic.—Of making Observations ones self and of taking them on trust.—Sir Isaac's second Rule condemn'd.—Microcosm and Macrocosm.—Mambrino's Helmet.*

A. *Very respectable young Gentleman*  
*A* of my acquaintance in a neighbouring County, having lately returned from his Travels, wrote to me, and among other things inform'd me, that he had been taught Philosophy by many different Masters, each of whom had adopted a favourite Theory of his own; and added, I am become quite a Sceptic in matters of Opinion, and even frequently in deductions from Facts.

This, it must be allow'd, is a most strange Confession, and shews him to be gotten into the very track which must necessarily conduct him to that bane of all Science, *Scepticism*, viz. that of being taught Philosophy by a multiplicity of Masters, each of whom had adopted a favourite Theory of his own.

B. Do you think Scepticism to be a natural Consequence of being taught Philosophy by different Masters.

A.



*A.* It must seem naturally to tend to it when each of those Masters had adopted a particular favourite Theory of his own.——

When my Friend was initiated into the Principles of the Theory of his first Master, no doubt but he might be well pleased with them, and by that time he had digested those Principles, perhaps he might imagine they were not to be refuted; but having enlisted under another Master, who had adopted a different Theory, he was soon unhing'd, as it were, with regard to the Principles of his first, and having attentively considered those Principles of his second Master, he might by that time very possibly imagine himself capable of instructing his former Master, thinking he was then arrived at the highest pitch of Knowledge; but he soon became convinced of his mistake by his third Master, who had adopted a different Theory from the rest. Thus by going from Master to Master, and still finding, that each one had adopted different Principles, he at length became quite a Sceptic, as he himself owns, insomuch as frequently to doubt even the evidence of his Senses, or what he styles deductions from Facts.

I must own, I could not but reflect with a kind of complacency on the remarkable difference between that young Gentleman's manner of being initiated into the *search of Nature*, and that of my own, and the different Effects produced thereby.—— He, who was taught

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Philosophy by different Masters, became quite a Sceptic ; whereas, I had no guide besides the dictates of Reason to conduct me, and the manner whereby the effects of electrical Experiments are reconciled with one another.

He also added in the same Letter, that he had perused my Philosophical Essays with great pleasure; tho' (he said) he continued to think, that my extensive Application of the electrical Power was by no means founded on sufficient Experiments ; yet, that it was with great pleasure, he saw new facts daily arising in confirmation of it. And says, though I cannot consider you as a Philosopher who has proved the point, I must look upon you as a Prophet who has foretold it.

When I had thoughts of writing a Supplement to those Essays, I wrote to him again (and to many others of my Acquaintance) to desire them to favour me with what Objections they thought any particular parts of them were liable to: my Reasons for desiring it I have given farther on.

From my Friend's present Answer I have great reason to conclude, that his passion for scepticism has not abated since his first Epistle. He obliged me indeed so far as to send me many objections to what I had advanced ; but in so cursory, captious, sneering, and ludicrous a manner, that if he had not professed himself to be *upon principle*, a philosophical Infidel, I should have thought myself ill-used by him.

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The first thing he objected to was what I had transcribed out of Bishop *Berkley's* *Siris*, and from Professor *Boerhaave*, concerning the vivifying Spirit in Air ; to which, all the reply he makes is "vivifying Spirit not demonstrated."

The Gentleman objecting against the vivifying spirit in air, because he thought it not sufficiently demonstrated, brought to my mind an Experiment of M. *Hauksbee*, made on Fishes ; which, as it seems a full Proof of what he thought were not sufficiently demonstrated, I shall take the liberty to insert it in the Author's own words, See Mr. *Hauksbee's* *Physico-mechanical Experiments*, exp. 16th. p. 304.

" The Fishes made use of in the following  
 " Experiments were Gudgeons, which are a  
 " sort of Fish very brisk and lively in the Wa-  
 " ter, and will live a pretty considerable time  
 " out of it. Three of them I put into a glass  
 " vessel to about three pints of common water  
 " (which Fishes were to be a standard to com-  
 " pare the others by). Into another glass, to  
 " a like quantity of water, I put three more  
 " of them, which quantity of water just filled  
 " this glass to the very brim ; upon which I  
 " screw'd down a brass Plate with a leather  
 " between, to prevent a communication with  
 " the water in the glass and the external Air :  
 " And that it might the better resemble a  
 " Pond of Water frozen over, (on which ac-  
 " count this Experiment was made) I suffer'd

" as



“ as little Air as possible to remain on the surface of the included Water.”

“ The third glass had a like quantity of water put into it as the former; which Water, first by boiling, then by continuing it a whole night in *vacuo* on the Air-pump, was purg’d of its Air to the greatest nicety (a): Into this water also, I put a like number of Gad-geons as into the other. Thus (the Fishes being all put into their respective Receivers) I applied myself to wait the event, which was as follows: It was about half an hour after ten in the morning when I began the Experiments; and in about half an hour from that time, I observ’d the Fishes in the exhausted Water, or Water purg’d of its Air, began to discover some uneasiness, by a more than ordinary motion in their Mouths and Gills, or Respiration, if I may call it so, differing from the Fishes in the other Glasses; the included Fishes at the same time disco-

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“ (a) From Experiments made with the electrical apparatus it never appeared that the Fluid in the Pores of Bodies could ever be taken away or removed by any means, otherwise than for an equal quantity of the same to supply its place, consequently there is no such thing as purging the Water of it in the manner Mr. Hauksbee supposed. It was morally impossible for him to have the same Reasons to believe that Fluid to be an elastic Fire as we find it is; and that not the least portion of it can quit its place but for an equal quantity of the same homogeneous Fire, so that it was no wonder that the Fishes breathed nearly as free in the Water, as though it had never been boiled nor under the Air-pump, particularly after they had been in it some small Time.

“ vering no alteration ; only I took notice that  
“ they would now and then ascend to the top  
“ of the water, but suddenly swim down again :  
“ And in this state they continued for some  
“ considerable time without any sensible alter-  
“ ation. About five hours after the last obser-  
“ vation, the Fishes in the exhausted Water  
“ became not so active (upon a motion given  
“ the Glas which contain’d them) as before :  
“ And those Gudgeons included without any  
“ communication with the outward Air, now  
“ began considerably to abate of their vivacity ;  
“ yet still continued at times their motion up-  
“ ward and down again. At seven in the even-  
“ ing the included Fishes lay all at the bottom  
“ of the Glas with their Bellies upwards ; nor  
“ upon shaking the glas could I set them in  
“ motion, or cause them to stir their fins or  
“ tails ; only I could observe a motion in their  
“ mouths, which shew’d they were not per-  
“ fectly dead. In this state they lay for some  
“ time : But considering the Experiment  
“ would not be complete, if I did not attempt  
“ their Recovery by taking off the brass cover,  
“ being very sure they must have died in some  
“ small time, under the Circumstances they  
“ were then in ; accordingly I took off the co-  
“ ver, and gave the surface of the Water a free  
“ and open communication with the external  
“ Air. At about ten at night I observ’d them  
“ again, at which time their Recovery was so  
“ evident that upon a little disturbing the glas  
“ that

“ that contain’d them, they were actually in  
 “ motion again: And at this time also, the  
 “ Fishes in the Water purg’d of its Air began  
 “ to appear more brisk and lively than at the last  
 “ observation. Here I cannot but take notice,  
 “ that notwithstanding the water was purg’d  
 “ of its air to a very great degree, yet the  
 “ fishes put into it did not so much as once  
 “ ascend in it; but continued always at the  
 “ bottom, as the Fishes did in the common  
 “ Water. At this time I left them till the  
 “ next Morning; when about Eight o’Clock  
 “ I found them as perfectly well and lively in  
 “ all the Glasses, as when they were first put  
 “ in. Those in the common Water exposed  
 “ to the open Air, suffer’d no manner of  
 “ Change during the whole Time. After this  
 “ I was willing to try whether the Air had  
 “ again insinuated it self into the purg’d Wa-  
 “ ter, and whether that might not be the  
 “ occasion of the Fishes Recovery. Accord-  
 “ ingly I put it on the Plate of my Pump, in  
 “ the same Glass with the Fishes in it; and  
 “ being cover’d with another Receiver, the  
 “ Air was taken from it; yet I could perceive  
 “ very little Air ascend in it, and to me it  
 “ seem’d much in the same State as when the  
 “ Fishes were first put in. I continued it *in*  
 “ *Vacuo* about an Hour and an Half; the  
 “ Fishes almost all the time continued at the  
 “ Top of the Water, and at that time appear-  
 “ ed as dead; for upon letting in the Air,  
 “ they



“ they sunk hastily to the bottom without any  
 “ Motion of their Fins or Tails.”

“ From the whole Account I observe ;

“ *First*, That Water purg'd of Air so far as  
 “ the Method here made use of, is capable to  
 “ do it, renders it not altogether unfit to sup-  
 “ port the Lives of Water Animals. For al-  
 “ though when the Fishes were first put in,  
 “ and for some Hours after, they seem'd to  
 “ suffer some uneasiness ; yet at length the  
 “ Water became more familiar to them, or  
 “ their Constitutions in some measure did so  
 “ conform, as to render the Water to them,  
 “ and them to the Water more agreeable :  
 “ Otherwise I do not see how their Recovery  
 “ should follow, since upon examining, little  
 “ or no alteration could be found in the  
 “ Circumstances of the Water, from the time  
 “ the Fishes were first put in.”

“ *Secondly*, The Fishes included with their  
 “ Water from any Communication with the  
 “ external Air, plainly demonstrate, that  
 “ common Water in its Natural State is not  
 “ alone sufficient to preserve the Lives of its  
 “ Natural Animals. Hence it follows, that  
 “ in Ponds, when the Water comes to be  
 “ Frozen over with a pretty thick Ice, the  
 “ Fishes in the said Ponds are very likely, if  
 “ not certain to perish, upon the Continuance  
 “ of such a Congelation for some time on their  
 “ Surfaces ; unless (as in the latter part of the  
 “ Experiment) the Impediment which hin-  
 “ der'd

“ der’d the immediate Contact of the Air to  
 “ the Surface of the Water, be remov’d; that  
 “ is, by breaking Holes in the Ice, whereby  
 “ it is restor’d, and undoubtedly will perform  
 “ the same thing as my Removal of the Brass  
 “ Plate. This is to be understood only in  
 “ Ponds where the Water is stagnant; for  
 “ where there are Springs, or a current of  
 “ Water constantly succeeding under the Ice,  
 “ the effect most likely will not be the same.

*Remark.* Can any thing be more plainly  
 proved by Experiment than the vivifying qua-  
 lity in Air? How soon were the Gudgeons in  
 the second Glass just on the point of expiring for  
 want of a communication with the external  
 Air; and how soon revived at the admission  
 of it? Who, unless he were *quite* a Sceptic,  
 can read the Experiment and not be convinced  
 of the vivifying quality in that Element.

B. What was his next Objection?

A. “ A clear glass Jar of fair Water was  
 “ put under the Receiver of an Air-pump,  
 “ where the exhaustion was no sooner begun,  
 “ but the little expansive particles were plainly  
 “ seen to rise and escape through the body of  
 “ the Water to the surface all the time of ex-  
 “ haustion”. ———

His whole Reply to which is ——— “ No  
 “ Proof that this is electric matter (*a*).

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(*a*) Since the Gentleman objects that it is no Proof, that  
 the Air rising out of the Water was electric matter, I should  
 be glad to be inform’d *what* it is? since Water is by no  
 means permeable by the common Air.

I had alluded to Sir *Isaac Newton's* second general Rule of Reasoning in Philosophy, viz. *To the same Effects we must as far as possible assign the same Cause*; the magnetic Virtue, which moves the iron or steel Filings beyond the Glass, and the Pneuma or electrical Virtue just discover'd, which moves the Feather, leaf Gold, leaf Brass, &c. so vigorously beyond the Glass must be the same identical subtile Agent, acting in different conditions and forms. I beg therefore this Rule may be particularly attended to, since many physical Experiments will be greatly illuminated by considering it attentively, which would otherwise seem much more abstruse and unintelligible.

*Objection.* “*Newton's* is a dangerous Rule. “ We are too apt to generalize Facts; it is “ pleasing to the Mind so to do, but it is de- “ structive to Knowledge.”

This Philosopher, like many others, seems to make a downright Stalking-horse of Sir *Isaac Newton*, since, like a mere Nose of Wax, he can put him on and off at pleasure. — I can however with great Truth affirm, that this is the first time I ever heard any of Sir *Isaac's* Rules so decried.

Essays, Sect. 129. 131. &c. Is concerning the Analogy between the Microcosm and Macrocosm. — This Analogy he treats with the utmost Contempt; and replies, “ It will “ not be allowed; it is a mere Dream, unwor- “ thy of a Philosopher; and seems alike in  
nothing



“ nothing but the sound of the two Words,  
 “ *Microcosm* and *Macrocosm*: *The Barber's*  
 “ *Basin and Mambrino's Helmet were more*  
 “ *alike*, which furnished such curious matter  
 “ of speculation to *Don Quixotte*.”

A. So keen a Sarcastm, thrown out against me by a particular Friend, was what I had no reason to expect; but I can disarm it of its sting by the single remark of a judicious Critic, who was so pleased with the Analogy, that he said a more just comparison was hardly to be met with: *Microcosm and Macrocosm being, in his Opinion, as much alike as a silver penny is to a five shilling piece*, both bearing the same stamp, and differing only in size.

B. I think your Friend has shewn his Wit at the Expence of his Judgement, and let him enjoy his dear-bought Purchase; but let us proceed.

A. He further affirms it to be “demonstrable that the elastic Air, discover'd to exist in the pores of gross Bodies, is very different from electric Matter,” although the direct contrary of this Assertion appears most evident; therefore the objection can never be admitted without proof.

Essays, part 3d, sect. 181. *Martin's Experiment*, he says, proves only that there is Air contain'd

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in these substances in an elastic state: " It does  
 " by no means prove that the greatest quantity  
 " of Air produced by Dr. Hales' Experiments  
 " was not in a fix'd state as a part of the Substance  
 " of the Body operated upon (a); and there is no  
 " doubt but a Body, after having all its elastic  
 " Air extracted by the Air-pump, would still  
 " yield nearly the same quantity of Air menti-  
 " oned in the Doctor's Experiments.

In Part 3d. chap. 11th of my Essays are contained two Experiments of that celebrated Writer Dr. Hales, who fancied he could, by Fermentation, Distillation, &c. metamorphose solid Bodies into Air.—Among many others, the two particular Bodies whereon the Experiments were made were the human Calculus and 54 cubical Inches of Brandy; One half of the weight of the former was converted into what he calls his artificial Air; whereas the latter

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(a) Here it is plain, that my Friend was credulous enough to think with Dr. Hales, that part of the gross substance itself was metamorphosed into Air.

When the Dr. made those Experiments, he had never seen any which proved that a most exquisitely rare, elastic and pure Air existed in the pores of gross Bodies; otherwise 'tis presumed he would never have broached so wild and inconsistent a Doctrine; whereas my Friend, being an accurate Electrician, was not necessarily ignorant of this as the Dr. was, and therefore the less excusable.

A Letter of Encomiums was sent me 150 Miles, containing among many other things the following observation on that particular subject. — " I thank you too for the Attention you have bestowed on that wild modern subject the generation of Air, to which I never could be reconciled, and always imagined the Fact to be as you have explain'd it."

afforded

afforded but very little. The Reason I assign'd for this was as follows.

The subtile Spirit or pure Air contained in the pores of those Bodies before their Dissolution do, when analyzed into their first Principles, naturally mix and incorporate with those minute particles of gross matter, in a similar manner, as when in their original state; and thus an artificial Air is generated as elastic and ponderous, and in most other respects the same as common Air, consequently as permanent as that — The easier the Body is dissolved, and the more free the terrestrial corpuscles rise in the Distillation, the greater is the quantity of *what* he calls the *new generated Air*. p. 387. Sect. 190.

This seems to be the only Reason, why so great a quantity was generated, when the human Calculus was distilled; one half of the weight of the stone was by this means volatilised and incorporated with the contained Ether. p. 387. sect. 191.

This appears likewise to be confirmed, by considering a quite different and contrary deception, which happened when the mass to be analyzed contained almost the greatest quantity of the pure elementary Air or Spirit, and very little gross matter. p. 387. sect. 192.

In Experiment 66. Vol. I. Dr. *Hales* found very little Air in 54 cubic Inches of Brandy: Had it been a highly rectified Spirit, he would have found none, all would have escaped, there



being no gross matter to rise and incorporate with it to prevent it. p. 387. sect. 193.

Hence it comes to pass, that when there is contained in the mass to be analyzed the greatest quantity of all, of the pure subtile elementary Air, that no artificial Air can then be formed. Rectified Spirits of Wine seem, as it were, the pure Air or Fire in a liquid form. p. 388. sect. 194.

To this he sneeringly replies, "Is Sir *Isaac Newton's* Æther then come at last to be rectified Spirit of Wine; and is Alcohol and Electricity the same thing?"

I answer, it is, and for the forementioned Reasons, i. e. when reduced to such a liquid Form; and whoever denies it will be expected to shew a more plausible one, why the human Calculus yielded so great a quantity of elastic Air, and why almost a quart of Brandy yielded so very little.

N. B. He made many more Objections, though not one that contained any thing remarkable. His Apology for not giving Reasons for the Objections he makes, is, that it would be too much for the compass of a Letter, which is thought but a slender Apology for giving no Reasons for hardly any of them; at least, not any that were supported with either Experiments or Arguments.

Having gone over the most material Objections which that Gentleman has made to my Essays, and finding them incapable of overturning

ing my Positions, I must beg leave to add, that where-ever I am wrong in my Principles, or deductions from them, it would give me the sincerest pleasure to be set right by any sagacious Enquirer, who is capable of affording me better Information.

It is much to be wished that a friendly Conference were carried on by the channel of some one of the periodical Papers, in order to settle philosophical Points, particularly such as are most doubtful. — We might then with ease and precision attempt to discuss even the very Fundamentals of Philosophy, and not without some reasonable hope of Success: I mean we might then pass a strict and just scrutiny on those grand Articles in dispute, at which even the most learned Men so grievously stumble; viz. whether an *universal Vacuum* exists or an *universal Plenum*. For when once that is satisfactorily settled, we should no longer halt between two such contradictory Opinions. If such an amicable Conference as abovemention'd were earnestly and properly pursued by way of *pro* and *con*, the most doubtful Cases would be brought to an Issue; since it must soon appear on which side the clearest and strongest Evidence lies.



## DIALOGUE. X.

Dr. Priestley upon the Universality of the electrical Phenomena.—*Water-spouts. A particular Hurricane. — Dr. Priestley imps an Earthquake. — What he Terms natural Electricity. — Dr. Henry More's Hylarchic Principle defined.*

B.  H O among the Moderns is look'd upon as the greatest Advocate for electrical Philosophy and the great Power and Force of the electrical Fire?

A. None can plead much more strenuously for those things, nor for the Universality of the Fire, than the ingenious Dr. Priestley, who informs his Readers of a variety of abstruse Phenomena of Nature which much perplexed the Philosophers, since they could never account for them in a satisfactory manner: Phenomena in the Heavens, in the Earth, and in the Sea; viz. Aurora Borealis, Lightning, falling Stars, Fire-drakes, Fire-balls, and other meteors. — Whirlwinds, Inundations, Hurricanes, Water spouts, &c. and even Earthquakes; all which are now with great reason supposed to be



be effects of this grand Agent, the electrical Fire.

The Dr. says, that “ the Aurora Borealis  
“ being an electrical Phenomena was, he be-  
“ lieves, never doubted from the Time that  
“ Lightning was proved to be one.”

He takes notice that “ the Meteor, hitherto  
“ called a falling Star, has puzzled all Philo-  
“ sophers.”

Signora Beccaria, (a) he says makes it pret-  
ty evident that it is an electrical Appearance;  
and the Fact which he relates as a proof of it,  
is exceedingly curious and remarkable, he in-  
forms us that,

“ As he was one time sitting with a Friend  
“ in the open Air an Hour after Sun set, they  
“ saw what is called a falling Star directing its  
“ course towards them, and apparently grow-  
“ ing larger and larger till it disappeared not  
“ far from them, when it left their Faces Hands  
“ and Clothes, with the Earth, and all neigh-  
“ bouring objects, suddenly illuminated with  
“ a diffused and lambent Light, attended with  
“ no noise at all. — While they were stand-  
“ ing up, staring and looking at each other,  
“ surprised at the appearance, a Servant came  
“ running to them out of a neighbouring Gar-  
“ den and asked them if they had seen nothing,  
“ for that he had seen a light shine suddenly in  
“ the Garden, and especially upon the Streams  
“ which he was throwing to water it.”

(a) An Italian Electrician.

Dr.

Dr. Priestly at p. 352. says, that Appearances, which bear evident marks of electricity, have a very sensible progressive motion is demonstrated from a variety of meteorological Observations. I shall relate one made by Mr. Chambers when he was on board the Montague under the Command of Admiral Chambers.

On the fourth of November 1749, in Lat.  $42^{\circ} . 48'$ . Long.  $9^{\circ} . 3'$ . he was taking an observation on the quarter Deck, about ten Minutes before 12 when one of the quarter Masters desired he would look to the Windward; upon which he observed a large Ball of blue Fire rolling on the Surface of the Water, at about three Miles distant from them. They immediately lowered their top Sails, &c. but it came down upon them so fast, that before they could raise the main Tack, they observed the Ball to rise almost perpendicular, and not above forty or fifty Yards from the main Chains; when it went off with an explosion as if hundreds of Cannon had been fired at one Time, and left so great a smell of Brimstone, that the Ship seemed to be nothing but sulphur. After the Noise was over, which he believed did not last longer than half a Second, they found their main Top-mast shattered into above a hundred Pieces, and the Main-mast rent quite down to the Heel. There were some of the Spikes, which nail the Fish of the Main-mast, drawn with such Force out of the Mast, and they stuck so fast

in

in the main Deck, that the Carpenter was obliged to take an Iron Crow to get them out. There were five Men knocked down, and one of them greatly burnt by the explosion. They believed, that when the Ball, which appeared to them to be of the bigness of a large Mill-stone, rose, it took the middle of the main Top-mast, as the head of the Mast above the hounds was not splinter'd.

Dr. Priestley informs us, "That the fore-mentioned Seignior *Beccaria* takes some pains to shew that Water-spouts have an electric Origin. To make this more evident he first describes the Circumstances attending their Appearance; which are the following."

"They generally appear in calm Weather; the Sea seems to boil and send up a smoke under them, rising in a hill towards the spout; at the same time Persons who have been near them have heard a rumbling Noise. The form of a Water-spout is that of a speaking Trumpet, the wider end being in the Clouds, the narrower end towards the Sea. The size is various even in the same spout. The colour is sometimes inclining to white, and sometimes to black. Their position is sometimes perpendicular to the Sea, sometimes oblique, and sometimes the spout itself is in the form of a curve. Their continuance is very various, sometimes disappearing as soon as formed, and sometimes continuing a considerable time; one that he

R

"had



“ had heard of continued a whole hour, but  
“ they often vanish, and presently appear in  
“ the same place.”

“ What Water-spouts are at Sea, the same  
“ are some kind of Whirl-winds and Hurri-  
“ canes by Land : They have been known to  
“ tear up Trees, to throw down Buildings,  
“ make Caverns in the Earth ; and in all these  
“ cases to scatter Earth, Bricks, Stones, Timber,  
“ &c. to great distances in every direction.  
“ Great Quantities of Water have been left or  
“ raised by them, so as to make a kind of de-  
“ luge ; and they have been always attended  
“ with a prodigious rumbling Noise.”

“ That these Phenomena of Water-spouts,  
“ &c. depend upon Electricity, cannot but  
“ appear very probable, from the nature of se-  
“ veral of them ; but the conjecture is made  
“ more probable from the following additional  
“ Circumstances. They generally appear in  
“ Months peculiarly subject to Thunder-  
“ storms, and are commonly preceded, accom-  
“ panied, or followed by Lightning, Rain, or  
“ Hail, the previous state of the Air being simi-  
“ lar. Whitish or yellowish flashes of light  
“ have sometimes been seen moving with pro-  
“ digious swiftness about them. And lastly,  
“ the manner in which they terminate exactly  
“ resembles what might be expected from the  
“ prolongation of one of the uniform protu-  
“ berances of electrical Clouds towards the Sea,  
“ the Waters and the Cloud mutually attract-  
“ ing

ing each other; for they suddenly contract themselves and disperse almost at once, the Cloud rising and the Water of the Sea under it falling to its level. But the most remarkable Circumstance, and the most favourable to the supposition of their depending upon Electricity is, that they have been dispersed by presenting to them sharp pointed Knives and Swords. This, at least, is the constant practice of the Mariners in many parts of the World where these Water-spouts abound; and he was assured by several of them that the method had often been undoubtedly successful."

B. To Seignior *Beccaria's* Theory of Water-spouts and Hurricanes, Dr. *Priestley* adds a description of a Hurricane in the West Indies.

A. We have frequent accounts of such dreadful Hurricanes in America, from which most other parts of the known World are happily exempted. — It is in a rainy Season, principally in the Month of August, that they are assaulted by Hurricanes the most terrible, to which they are subject from the Climate.

" This Calamity destroys at one stroke the Labours of many Years, and frustrates the most exalted hopes of the Planter; and often just at the moment when he thinks himself out of the reach of fortune.—It is a violent storm of Wind, Rain, Thunder, and Lightning, attended with a furious swelling of the Sea, and sometimes with an Earthquake; in

“ short, with every Circumstance which the Elements can assemble, that is terrible and destructive.”

“ First, They see, as a prelude of the ensuing havock, whole Fields of Sugar-canes whirl’d into the Air, and scatter’d over the face of the Country. The strongest Trees of the Forest are torn up by the Roots and driven about like stubble. Their Wind-mills are swept away in a moment. Their Works, the fixtures, the ponderous copper Boilers, and Stills of several hundred weight are wrench’d from the ground, and batter’d to pieces. Their Houses are no protection : The Roofs are torn off at one blast ; whilst the Rain, which in an hour rises five feet, rushes in upon them with an irresistible violence.”

The Historian informs us, that Dr. *Stukely* was of Opinion “ That Earthquakes were the probable effects of electrical Fire, upon the occasion of the two Earthquakes in *February* and *March* 1749 ; and another in *Northamptonshire* in *September* 1750. The Papers which Dr. *Stukely* deliver’d to the Royal Society on these occasions, which were read “ in *March* 1749, and *December* 1750.” Dr. *Priestley* says, “ are valuable, and well deserve the Attention of all Philosophers and Electricians.”

“ That Earthquakes are not owing to subterraneous Winds, Fires, Vapours, or any thing that occasions explosions, and heaves  
up



‘ up the ground, he thought might easily be  
‘ concluded from a variety of Circumstances.  
‘ In the first place, he thought there was no  
‘ remarkable evidence of any cavernous struc-  
‘ ture of the Earth ; but that on the contrary,  
‘ there is rather reason to presume that it is in  
‘ a great measure solid, so as to leave little  
‘ room for internal changes and fermentations  
‘ within its substance ; nor do Coal-pits, he  
‘ says, when on fire, ever produce any thing  
‘ resembling an Earthquake.”

“ It is not,” he says, “ upon the principle  
‘ of any subterraneous explosion that we can, in  
‘ the least, account for the manner in which  
‘ Ships, far from any land, are affected during  
‘ an Earthquake ; which seems as if they struck  
‘ upon a rock, or as if something thump’d  
‘ against their bottoms : Even the fishes are  
‘ affected by an Earthquake. This stroke there-  
‘ fore must be occasioned by something that  
‘ could communicate motion with unspeakably  
‘ greater velocity than any heaving of the earth  
‘ under the sea by the elasticity of generated  
‘ vapours ; this could only produce a gradual  
‘ swell, and could never give an impulse to the  
‘ water so as to make it feel like a stone.”

“ The Impression made by an Earthquake  
‘ by land and waters to the greatest distances  
‘ is observ’d to be instantaneous ; which could  
‘ only be effected by Electricity. In the Earth-  
‘ quake in *September*, the Concussion was felt  
‘ through a space of 100 miles in length and

‘ 40 in breadth, and as far as could be judg’d  
‘ at the same instant of time. That this tract  
‘ of Land, which amounted to 400 square  
‘ miles in surface, should be thrown into such  
‘ an agitation in a moment, is such a prodigy,  
‘ the Dr. says, as we could never believe or  
‘ conceive, did we not know it to be fact from  
‘ our Senses. But if we seek the solution of it,  
‘ we cannot think any natural Power equal to  
‘ it, but that of Electricity, which acknow-  
‘ ledges no sensible transition of time, no  
‘ bounds !”

“ THE little damage generally done by  
‘ Earthquakes, the Dr. thought to be an Ar-  
‘ gument of their being occasioned by a simple  
‘ vibration, or tremulous motion of the surface  
‘ of the Earth by an electrical snap. This  
‘ vibration,” he says, “impressed on the Water,  
‘ meeting with the solid bottoms of Ships and  
‘ Lighters, occasions that thump which is said  
‘ to be felt by them ; yet of the millions of or-  
‘ dinary Houses, that it passed over, not one  
‘ fell. A Consideration which sufficiently points  
‘ out, what sort of a motion this was not, also  
‘ what sort of motion it was ; and whence de-  
‘ riv’d : Not a Convulsion in the bowels of the  
‘ Earth ; but an uniform vibration along its  
‘ surface like that of a musical string, or what  
‘ we put a drinking Glass into by rubbing one’s  
‘ finger on the edge, which yet, being brought  
‘ to a certain pitch, breaks the Glass ; un-  
‘ doubtedly,” he adds, “an electrical repul-  
‘ sion of its parts.”

“ That

“ That Earthquakes are electrical Phenomena is further evident,” he says, “ from their chiefly affecting the Sea-coast, places along Rivers, and, I may add, eminences. The Earthquake in *September* spread mostly to the North and South ; which” the Dr. says, “ is the direction of the Spalding River ; whereby it was conveyed to the Sea-shore, where it was particularly sensible ; thence up Boston Channel, and so up Boston River to Lincoln. The greatest part of this Earthquake displayed its Effects along and between the two Rivers Welland and Avon ; and that from their sources down to their mouths : It likewise reached the River Witham, which directed the electrical stream that way also to Lincoln ; for which reason, meeting the same coming from Boston, it was most sensibly felt there. It reach’d likewise to the Trent at Nottingham, which convey’d it to Newark.”

“ The first electrical stroke in this Earthquake seem’d to the Dr. to have been made on the high ground about Daventry in Northamptonshire. From thence it descended chiefly eastward, and along the River Welland, from Harborough to Stamford, Spalding and the Sea ; and along the Rivers Avon and Nen to Northampton, Peterborough, Wisbich and the Sea : It spread itself all over the vast level of the Isle of Ely, promoted by a great number of Canals, natural and artificial, made for



‘ for draining that Country. It was still conducted eastward by Mildenhall River in Suffolk to Bury and the parts adjacent. All these Circumstances duly considered were to him a Confirmation of the Doctrine he advanced on that subject.”

“ It must seem very surprising and unaccountable to Persons unacquainted with Electricity, that all this could be performed in the least instant of time, notwithstanding it was conducted to, and touch’d at so many different places. However, the sagacious Experimentalist is well assured, that this is a most undoubted truth; and our electrical Experiments are manifest proofs, that the progressive motion of the Fire is so instantaneous as not to admit of the least sensible transition of time in its passage, even to the most distant parts.”

According to Dr. *Priestley*, not only Dr. *Stukely*, but the renowned Dr. *Hales*, Mr. *Hartman*, and others were of Opinion, that Earthquakes were electrical Phenomena.

The Dr. observing the electrical Fire from his Battery to pass over the surface of the Water (*a*), in order to arrive at his brass Rod, says, “ The resemblance of the electric matter over the surface of the water, and that which Dr. *Stukely* supposed to sweep the surface of the earth, when a considerable quantity of it is discharg’d to the clouds during an Earthquake, immediately suggested to him, that the

(*a*) See his History of Electricity, p. 649. Water

Water in his Experiment over which the electrical Fire passed, and which was visibly thrown into a tremulous motion thereby, must receive a concussion resembling that which is given to the Waters of the Sea on such an occasion."

"To try this," he says, "Myself and several other Persons who were present, put our hands into the water, when an electric flash, as before, passed over its surface, and we felt a sudden Concussion given to them exactly, like that which is supposed to affect Ships at Sea during an Earthquake."

B. These are most wonderful Accounts indeed! as well as entertaining: Pray, what is the next thing we are to consider?

A. I shall furnish you with some further Observations of the same ingenious Author, who, at p. 370 says, "I shall close this account of the Theory of Lightning, and other Phenomena of the Atmosphere, with an enumeration of the principal Appearances of *natural* Electricity observ'd by the Antients, and which were never understood before the discovery of Dr. *Franklin*. It will be very easy for me to do this, as I find them already collected to my hands by Dr. *Watson* (a)."

"A luminous appearance, which must have been of an electrical nature, is mentioned by *Plutarch* in his *Life of Lysander*."

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(a) *Philosoph. Transact.* Vol. 48. Exp. 1st. p. 210.

“ *Pliny*, in his second Book of Natural History, calls those appearances Stars ; and tells us, that they settled not only upon the Masts and other parts of Ships; but also upon Men’s Heads.”

“ Stars make their appearance both at Land and Sea. I have seen a light in that form on the Spears of Soldiers, keeping Watch by night, on the Ramparts. They are seen also on the Sail-yards, and other parts of Ships, making an audible sound, and frequently changing their places. Two of these lights forebode good weather, and a prosperous Voyage; and drive away one that appears single, and wears a threatening Aspect. This the Sailors call *Helen*, but the two they call *Castor* and *Pollux*, and invoke them as Gods. These lights do sometimes, about the evening, rest on Men’s Heads, and are a great and good omen. But these are among the awful Mysteries of Nature.”

“ *Seneca* in his natural Questions, chap. I. takes notice of the same Phenomena.—A Star settled on the Lance of *Gylippus*, as he was sailing to *Syracuse*; and Spears have seem’d to be on fire in the Roman Camp.”

“ About that time there was a very extraordinary Appearance in the Army of *Cæsar*. In the month of February, about the second watch of the night, there suddenly arose a thick cloud followed by a shower of stones; and the same night, the points of the Spears  
‘ belonging



‘ belonging to the fifth Legion seem’d to take  
‘ Fire.”

“ The Spears of some Soldiers in Sicily,  
‘ and a walking stick, which a Horseman in  
‘ Sardinia was holding in his hand, seem’d to  
‘ be on fire. The Shores were also luminous  
‘ with frequent Fires.”

“ These Appearances are called both by the  
‘ French and Spaniards, inhabiting the Coasts  
‘ of the Mediterranean Sea, St. Helme’s or St.  
‘ Telme’s Fires ; by the Italians, the Fires of  
‘ St. Peter and St. Nicholas.” And are fre-  
quently taken notice of by the Writers of Voy-  
ages.

“ If some late accounts from France (adds  
‘ the Dr.) are to be depended on, this Pheno-  
‘ menon has been observ’d at Plauzet for time  
‘ immemorial, and Mr. *Binon* the Cure of the  
‘ place, says, that for twenty seven Years, which  
‘ he has resided there, in great storms accompani-  
‘ ed with black Clouds, and frequent Lightnings,  
‘ the three pointed extremities of the cross of  
‘ the steeple of that place appear’d surrounded  
‘ with a body of flame ; and that when this  
‘ Phenomenon has been seen, the Storm was  
‘ no longer to be dreaded, and calm weather  
‘ returned soon after.”

“ Modern History furnishes a great number  
‘ of Examples of Flames appearing at the ex-  
‘ tremities of pointed metallic Bodies, projecting  
‘ into the Air. Little notice was taken of these,  
‘ while the cause of them was unknown ; but

‘ since their near affinity with Lightning has  
 ‘ been discover’d, they have been more attended  
 ‘ to and collected. ”

Here it may be observ’d, that electrical Philosophers are not singular in representing the electrical Fire as an universal Principle: Dr. *Priestley* seems entirely of their Opinion, and supposes that all the appearances which he had been enumerating were *electrical Phenomena*, that is, that they were effects of electrical Fire.

B. What do electrical Philosophers think reasonable to conclude from such Appearances?

A. That from such an ample field, such a vast fund of indubitable facts, they may safely conclude the electrical fluid to be a general Agent, and an universal Principle in the strictest Sense; since there was a great variety of appearances in nature which seem’d to point out such a general active Agent or first instrumental mover, too obvious to be overlook’d by the most sagacious Philosophers of all Ages; many of whom, both antient and modern, seem by their Writings to have had very clear glimpses, and adequate Ideas of it, before it was actually discover’d by modern Experiments, though distinguished by different Appellations — as Fire, *Anima Mundi*, Subtile Medium or *Æther*, *Materia subtilis*, &c. — *Chambers* under the term *Anima Mundi* informs us, that some suppose Plato by his *Anima Mundi* to have meant God or the spirit of God, and to have taking

taken the hint from Moses, who in his account of the first day's Creation says, "*the Spirit of God moved on the Face of the Deep.*"

"The modern Platonists explain their masters' *Anima Mundi* by a certain universal ætherial Spirit, which in the Heavens exists perfectly pure, as retaining its proper nature; but, on Earth, pervading elementary Bodies, and intimately mixing with all the minute Atoms thereof, assumes somewhat of their nature, and becomes of a peculiar kind."

"They add, that this *Anima Mundi*, which more immediately resides in the celestial Regions as its proper seat, moves and governs the heavens in such a manner, as that the heavens themselves first received their existence from the fecundity of the same Spirit: For that this *anima* being the primary source of Life, every where breath'd a Spirit like itself; by virtue whereof various things were framed conformable to the Divine Ideas."

Sir *Isaac Newton's* subtile Medium or Æther exactly coincides with the *anima mundi* of the Platonists. The Cartesians have their subtile matter, which answers to most of the Uses and Intentions of the same Principle. The learned *Bishop of Cloyne*, as well as many of the antient Philosophers, substitute fire as the *anima mundi*, which appears to come nearest of all to the electrical Philosophy.—— The Appellation, *Nature*, is explain'd much in the same manner.

"The



“ The word Nature in a strict sense is used  
 ‘ for the Action of Providence, the Principle  
 ‘ of all things, or that Spiritual Power or Be-  
 ‘ ing which is diffused throughout the Creation,  
 ‘ and moves and acts in all Bodies, and gives  
 ‘ them certain Properties and produces certain  
 ‘ Effects. This is the Sense which Mr. *Boyle*  
 ‘ considers as the most usual. NATURE is  
 ‘ nothing else but God, acting himself, and  
 ‘ according to certain Laws, which he himself  
 ‘ has fixed.”

“ This seems pretty agreeable to the opinion  
 ‘ of many of the Antients, who made Nature  
 ‘ the God of the Universe, who presides over  
 ‘ and governs all.”

“ *F. Mallebranche* says, the Nature so much  
 ‘ talk’d of in the Schools is fit for nothing but  
 ‘ to lead us back to Idolatry : The antient  
 ‘ Heathens hereby understanding something,  
 ‘ which without being God, acts continually  
 ‘ throughout the Universe. Thus the idol  
 ‘ Nature must be an actual Principle which  
 ‘ under God is the next and immediate cause  
 ‘ of all the changes which befall matter, which  
 ‘ seem to fall in with the opinion of the *Ani-  
 ‘ ma Mundi*; as if Nature were a substitute  
 ‘ of God, or a collateral cause with God, or a  
 ‘ middle Being between God and created  
 ‘ Things.” Vide *Chambers* under the word  
 Nature.

To these might be added the learned Dr.  
*Henry More*’s hylarchic Principle or universal  
 Spirit

Spirit of the World, which he thus defines:—

• A Substance incorporeal, but without  
• Sense and Animadversion, pervading the  
• whole matter of the Universe, and exercising  
• a plastical Power therein according to the  
• sundry predispositions and occasions in the  
• parts it works upon; raising such Phenomena  
• in the world, by directing the parts of the  
• matter and their motion, as not to be resolved  
• into mere mechanical Powers (a).”

## DIALOGUE. XI.

### On M O T I O N.

*Different Opinions concerning Motion.—*

*The Existence of it denied.—Different  
and fallacious Methods made use of to  
prove the same, by Diodorus Cronus.*

*—Zeno and Others endeavouring to  
prove that Achilles, tho’ ever so swift,  
could never overtake a Tortoise, altho’  
the slowest of Animals.—Dr. Keil,—*

*Mr. Rowning,—Des Cartes, and Dr.  
Stevenson’s Sentiments on Motion.*

B. **H**OW do modern Philosophers account for the Origin of Motion?

(a) See his Treatise Book 3d. Chap. 12. p. 193.

A. The cause of Motion in the World has been much controverted, and esteemed one of the most abstruse Phenomena. Many eminent Philosophers have made much enquiry concerning its nature, and taken great pains to shew whence it proceeds. Some suppose it to be a Principle or Property inherent in Matter or Body itself, whilst others are of opinion, that it is a created Essence, distinct from matter, and acts as a Cause: Many other wild and incoherent notions of it have been at different times maintained, all of which seem owing to the perplexed state the subject was necessarily involved in; necessarily I say, it being next to impossible to form any adequate Idea of the cause of motion before Fire was discovered, by means of the electrical Apparatus, to be a permanent, durable Principle.

B. How do modern Philosophers account for the Cause of Motion?

Dr. Keil, In the 6th Lecture of his Introduction to natural Philosophy, p. 68. Edi. 2d. when speaking of motion calls it "the noblest Affection that Body is endued with; (a) by the mediation whereof nature discovers herself acting in that variety of things which ought not to be beheld without wonder and astonishment, and without which all the ornament and beauty in the world would per-

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(a) Here it is plain Dr. Keil, was of Opinion that motion was a Property or Quality inherent in Matter,



' ish, and a horrid darkness and an infinite  
 ' numbness would possess every thing. On this  
 ' depend the vicissitudes of days and nights,  
 ' and the so great variety of cold and heat,  
 ' snow, rain, and sun-shine, succeeding each  
 ' other, and all the seasons of the year. By  
 ' Motion, Plants grow, Trees are nourish'd,  
 ' and Animals live; since Life itself consists  
 ' only in Motion, that is the Circulation of the  
 ' Blood. But why do I spend time in enu-  
 ' merating particulars, since all things owe  
 ' their birth to Motion?"

" The Science therefore of Motion is so  
 ' necessary to philosophise aright, that not the  
 ' least operation of nature can be investigated  
 ' without it. Hence the famous and most  
 ' true saying of the Philosopher, *Motion being*  
 ' *unknown, Nature must of necessity be so like-*  
 ' *wise.*"

" The Philosophers, or rather Metaphysicians  
 ' have had various disputes concerning the  
 ' Nature, Causes, and Communication of Mo-  
 ' tion; and the Confusion of Ideas, and the  
 ' Darkness that thence arose, appear to have  
 ' been so great, that amongst the Follies of  
 ' Disputation, the natural and simple notion  
 ' that they had of it, seems to have been lost  
 ' amongst them. For there can scarce be  
 ' found one of the common People, or the  
 ' meanest Artificer, but he knows more of the  
 ' true *Nature* and *Cause* of Motion than all  
 ' these wrangling Philosophers together; some

‘ of whom were arrived to that height of Folly,  
‘ as to deny all Motion as a thing impossible  
‘ to Bodies; and they propose some Cavils,  
‘ whereby they flatter themselves, that they  
‘ had demonstrated its impossibility.”

“ We will produce here some of their strongest Arguments; and the first shall be that of *Diodorus Cronus*, namely, If a Body moves, it must either move in the place where it is, or in the place where it is not, both which are impossible: For if it moves in the place where it is, it will never depart from that place, and so there will be no motion: In like manner it cannot move where it is not, because nothing acts in the place where it is not; therefore a Body will not move at all. I answer, that a Body neither moves in the place where it is, nor in the place where it is not; but it moves from one place to another.”

“ The second Argument shall be that of *Zeno*, to which he gave the name of *Achilles*; and therefore endeavours to prove that if there be any such thing as motion, *Achilles*, though ever so swift, could never overtake a *Tortoise* though the slowest of Animals. The Argument is this: Suppose *Achilles* to be distant from the *Tortoise* a certain finite space, as for example, a mile; and let us suppose he moves an hundred times faster than the *Tortoise*; therefore whilst *Achilles* runs one mile, the *Tortoise* has moved the hundredth part of a mile; so that *Achilles* has not yet overtaken

overtaken the Tortoise: And again, whilst  
*Achilles* passes over that hundredth part of a  
 mile, the Tortoise, in the mean while, will  
 have creep'd through the ten thousandth part  
 of a mile; insomuch that neither has *Achilles*  
 yet overtaken the Tortoise. After the same  
 manner, whilst *Achilles* runs the ten thou-  
 sandth part of a mile, the Tortoise will have  
 advanced forward the millionth part of a  
 mile; so that *Achilles* has not yet come up  
 with the Tortoise. And so he may go on *in*  
*infinitum*; nor will he ever be able to over-  
 take the Tortoise; but there will be always  
 some distance between Achilles and the Tor-  
 toise."

"This is the famous Argument of *Zeno*;  
 to answer which, some have written whole  
 Treatises: But we shall easily dissolve the  
 knot, by saying, that a Mile, together with  
 the hundredth part of a mile, together with  
 the ten thousandth part of a mile, with the  
 millionth part of a mile, and so on *in infinitum*,  
 will be equal to a finite quantity. For it is  
 demonstrated by the Arithmeticians, that the  
 sum of any series of quantities decreasing in  
 any geometrical proportion *in infinitum*, will  
 be equal to a finite quantity; but the hun-  
 dredth part of a mile, together with the ten  
 thousandth part of a mile, together with the  
 millionth part, together with the hundred  
 millionth part, and so on *in infinitum*, is a  
 series of quantities, decreasing in geometrical



' proportion *in infinitum* : So that its sum,  
 ' since it is equal to a finite quantity, may be  
 ' run over by a body moving with a given ve-  
 ' locity, in a finite time. For let us suppose  
 ' *Achilles*, in the space of an hour, to run a  
 ' mile, therefore he will pass over the hun-  
 ' dredth part of a mile in the hundredth part  
 ' of an hour, and the ten thousandth part of a  
 ' mile in the ten thousandth part of an hour;  
 ' and after the same manner he will move  
 ' through the millionth part of a mile, in the  
 ' millionth part of an hour; and so of the rest.  
 ' If therefore one hour, together with the hun-  
 ' dredth part of an hour, together with the ten  
 ' thousandth part of an hour, together with  
 ' the millionth part of an hour, together with  
 ' the hundred millionth part of an hour, &c.  
 ' *in infinitum* : If, I say, the sum of the series  
 ' continued *in infinitum* is equal to an infinite  
 ' space of time, it is certain *Achilles* would  
 ' never overtake the *Tortoise* in any finite  
 ' space of time : But since, as we said before,  
 ' the hundredth, ten thousandth, millionth,  
 ' &c. parts of an hour, is a series of quantities  
 ' decreasing in geometrical proportion *in infini-*  
 ' *tum*, its sum will be equal to a finite quantity,  
 ' viz. the ninety ninth part of an hour, as  
 ' might be demonstrated; and within that space  
 ' of time, all the particles of time, however  
 ' infinite in number, will be passed by. We  
 ' say therefore, that *Achilles* will overtake the  
 ' *Tortoise*, after one hour; and all those parti-  
 ' cles

cles of time, contained in the foregoing series, and which are infinite in number, are expired, that is, he will arrive at the Tortoise, after one hour and the ninety ninth part of an hour; and so the force of this Argument is destroyed; though its Patrons have so often boasted of it as unanswerable."

Thus the Dr. goes on haranguing and trifling with his Pupils about the word Motion; but never attempts to make the least enquiry after its *Cause*, though he exclaims so much at others for not doing it. This Story of Achilles and the Tortoise put me in mind of another, which might have been proposed, as bearing some affinity to it, though equally trifling, viz. If the hour and minute Indexes of a Clock were both of them to set out from the hour 12, for according to their fallacious method of arguing, the minute Index, although it moved 12 times faster than the other, could yet never be able to overtake it. This Problem, like the other, would be found a series of numbers decreasing in geometrical proportion.

As a solution of this Problem may amuse some Tyros, I shall take the Liberty of obliging them, and others, if they please, may pass it over.

First, Since in the time that the minute Index moves 12 hours, the hour Index moves but one hour, the proportion will be as 12 to 1, consequently, as  $12 : 1 :: 1 : \frac{1}{12}$ , and as  $12 : 1 :: \frac{1}{12} : \frac{1}{144}$ , of  $\frac{1}{12}$ , and so on *in infinitum*, viz. a series

series of quantities continually decreasing in geometrical proportion. — *Secondly*, The most concise method of solving this will be by specious Arithmetic: The proportion being as 12 is to 1; let  $a = 12$  and  $b = 1$ , then as  $a : b :: b : \frac{bb}{a}$ , and as  $a : b :: \frac{b^2}{a} : \frac{b^3}{a^2}$  and as  $a : b :: \frac{b^3}{a^2} : \frac{b^4}{a^3}$  and so is  $\frac{b^4}{a^3} : \frac{b^5}{a^4} :: \frac{b^5}{a^4} : \frac{b^6}{a^5} :: \frac{b^6}{a^5} : \frac{b^7}{a^6}$  &c. a series of quantities decreasing in geometrical proportion *in infinitum*.

*Thirdly*, If the solution be perform'd by sexagenary Arithmetic, the Series will be 1 hour, 5 minutes, 27 seconds, 16 thirds, 21 4ths, 49 5ths, 5 6ths, 27 7ths, 16 8ths, 21 9ths, 49 10ths, 5 11ths, 27 12ths, 16 13ths, 21 14ths, 49 15ths, &c. *in infinitum*; the five numbers 5, 27, 16, 21, 49, will continually circulate, or be repeated, consequently the Series can never terminate; however we are certain at the beginning of the Series, that the whole time amounts to but little more than 1 hour, 5 minutes, 27 seconds, and that all the following part of the series, though carried on ever so far, cannot amount to so much as half another second of time. — Dr. Keil instances in two or three more, but all equally trifling.

Mr. Rowning in his Introduction to his system of natural Philosophy, informs us that “*Des Cartes* supposes that God created a certain quantity of Motion, and assigned it to the whole mass of created Matter, and that motion



' motion being once created could no more  
 ' be annihilated without an Omnipotent hand,  
 ' than Body itself; in consequence of which,  
 ' he was obliged to teach, that the quantity  
 ' of Motion is always the same; so that if all  
 ' the Men and Animals in the World were  
 ' moving, yet still there would be no more  
 ' Motion than when they are at rest; the  
 ' Motion which they had not when at rest  
 ' being transferred to the Æther. So unac-  
 ' countable are the Motions of this great Phi-  
 ' losopher, that it is surprising his Doctrine  
 ' should have met with such universal reception  
 ' and have got so strong a party of Philosophers  
 ' on its side: That notwithstanding it was  
 ' more absurd than the Schoolmen's substantial  
 ' forms, they must all be exploded to make way  
 ' for his ingenious Hypothesis."

The same Author informs us, that "so  
 ' wild and extravagant have been the notions  
 ' of a great part of Philosophers both ancient  
 ' and modern, that it is hard to determine  
 ' whether they have been more distant in their  
 ' sentiments from the Truth or from one ano-  
 ' ther, or have not exceeded the Fancies of  
 ' the most fabulous Writers, even Poets and  
 ' Mythologists. ——— This was owing to a  
 ' precipitate proceeding in the searching into  
 ' Nature; their neglecting the use of Geome-  
 ' try and Experiments, the most necessary  
 ' helps to the finding out of Causes, and pro-  
 ' portioning them to Effects." — But, Mr.

*Rowning*

*Rowning* himself is here guilty of a great mistake that he was not aware of, nor indeed could he be: The only Reason of such different sentiments was, that former Philosophers, being ignorant of that universal Fire, which we have since discovered, were necessarily wrong in many things; this is what appears to be the true Reason of that variety of different Sentiments among them. Mr. *Rowning* is silent as to the Cause of Motion any farther than informing us what were the Sentiments of *Des Cartes* concerning it, as abovementioned.

According to Dr. *Stephenson*, Motion is an absolute Cause, and acts as a delegated Agent to bring about or produce natural Effects.

“ Among secondary Causes, Motion, he says, is the principal immediate Agent and Instrument of all the Effects, Operations and Phenomena, that are produced in the material Universe, and is the primary Cause upon which the Power, Force, and Energy of every Body, or System of Bodies wholly depends. For Matter, or Bodies without Motion, can neither suffer any change in themselves, nor produce any change or alteration in other Bodies, but would remain for ever in a state of absolute Rest and Inactivity; so that whatever changes or mutations happen in Bodies, the same are all necessarily produced by Motion, either added thereto, or subtracted therefrom. For which Reason we find, that

‘ according

according to the present established order of  
 Nature, matter and motion are render'd in-  
 separable; the whole system of matter, and  
 all material Beings, both animate and inani-  
 mate, being for ever subject to some degree  
 of motion, more or less, by which they are  
 kept in a continual circulation or fluxion,  
 and thereby fitted to undergo and pass thro'  
 different states, forms, periods and appear-  
 ances, according to the final Ends and Ap-  
 pointments of Providence. And thus we  
 observe, that all animal and vegetable Bodies  
 from the highest to the lowest degree in the  
 Scale of Life, as well as all other material  
 Beings, even the great Planetary and Come-  
 tary Bodies themselves, which compose this  
 Solar System, are constituted and formed to  
 continue only for a certain Revolution and  
 Period, some longer, some shorter, which is  
 no other than a progressive motion, whereby  
 they pass through different scenes and states,  
 and put on different forms and appearances,  
 which when accomplished, they become re-  
 solved again into the general elementary mass  
 of matter, though even then they are neither  
 divested of Existence, nor Motion, but are  
 still in a Progression to new Life, Form and  
 Being (a). — See Dr. *Stephenson's* Introduc-  
 tion to his Mechanical Physician, p. 11. or  
 p. 242. of the *Essays*.

*Essays*, part 2d. Sect. 146. — “ If we

(a) Here note, that the Dr. treats on Motion as a Cause,

U

do



do but cast an eye of Contemplation on the general Phenomena of Nature, we perceive Motion in almost every part. — That the matter contain'd in the visible Creation is full of motion, is so obvious as not to be denied; tho' the mechanical Cause of it, and how supported and preserved, has been much controverted. But so long as we were ignorant of the *Existence* of Fire as a durable Principle, so long were we necessarily ignorant of the Cause of such *Motion*. Before such a subtile Medium or *Æther* was discovered, the Cause of *Motion* was given up, along with other immechanical Causes, to be perform'd by the immediate influence of the First Cause."

"Before such a Discovery was made, we seem'd naturally enough to conclude, that all Matter was inert; whereas we now find we were greatly mistaken, and that there are active particles of matter existing, as well as passive, the effects of which active particles, particularly those contain'd in the pores of gross Bodies, were such, that the gross particles *themselves* appeared (in many different Circumstances) to be endued with *active Properties*. But had we attended to Sir *Isaac's Principia*, we might have learned better: There he informs us, that the cause of that activity is not in the gross particles themselves, as we imagined, but in the subtile elastic Medium existing in their pores (a)."

(a) See the last Paragraph of his *Principia*.

"This

"This was a much more natural description of it than could at that time have been reasonably expected, particularly, as Sir Isaac confess'd he was at a loss for proper Experiments to investigate the laws by which it operated."

"Nature almost every where appears replete with physical Causes to produce all kinds of necessary motions, not only among Animals, Vegetables, &c. but even in the celestial Regions.——For all motions in the Microcosm, both voluntary and natural, the most ample provision is made: And can we imagine a less provision for motion in the Macrocosm, particularly, now we have made a complete discovery of such an active and extensive Agent, existing in Nature, as was never credited before?"

"A principal Cause of Motion among inanimate things is the destroying and restoring the Equilibrium; the effects of almost all those remarkable Experiments in Electricity, appear to be founded on Nature's Efforts to restore the destroy'd Equilibrium, by means of the exquisite elasticity and rarity of the subtle fluid, alternately exerting their different and contrary forces, acting with, or counteracting the spring and pressure of the Atmosphere. Heat and Cold are likewise productive of like effects; which two opposite qualities are wonderful, and were in such remarkable esteem with the great Lord Bacon,

that

‘ that he compared them to the two hands of  
 ‘ Nature. How much more then had he liv’d  
 ‘ to see the surprising Effects of Opposites,  
 ‘ which are brought about by those two inhe-  
 ‘ rent Properties of this grand Principle of Na-  
 ‘ ture, namely, exquisite rarity and elasticity  
 ‘ in the medium just discover’d.”

“ Those, who had rejected such a medium,  
 ‘ and consequently such a manner of reasoning,  
 ‘ were much distress’d for the Cause of Motion,  
 ‘ having thereby shackled themselves with in-  
 ‘ superable Difficulties and Inconsistencies.”



## DIALOGUE. XII.

### *On the* CAUSE of GRAVITY.

B. \*\*\* H A T is Gravity? For I must  
 \*\*\* W \*\*\* confess, I have but a very confus’d  
 \*\*\* I \*\*\* Idea of it, it being used in so many  
 different Senses, as if the Word  
 was design’d to be guarded from having any  
 particular meaning at all. The word *Attraction*  
 is frequently used instead of it: Sometimes  
 it is made use of as a Cause, sometimes as an  
 Effect: Sometimes we have the expressions,  
*Attraction* or *Gravity*, just as if those two words  
 had but one and the same meaning, and might



be used promiscuously, with many other inconsistencies, as *Attraction and Gravity*; *Attraction or Gravity*; *Attraction of Gravity*; *Attraction of Cohesion*; *Attraction of Magnetism*; *Attraction of Electricity*, &c. &c. In short, I can, as I said, find no meaning affixed to either of the two words *Gravity* or *Attraction*?

A. What you say is true, and was all owing to the perplex'd state of things and the obscurity in which Philosophy was then involv'd. The case was the same with the present Electrical Philosophers; nor could they extricate themselves before the modern Experiments cleared away the darkness: To say the truth, before that time it was morally impossible to behold things as they really were; the inconsistencies and dissimilarity of Men in making use of two such different words in one and the same Sense is too apparent to be denied.

B. What are the Sentiments of Electrical Philosophers as to this intricate subject, *Gravity*; for it would be a great satisfaction to me to hear a rational account of it?

A. I will readily give you the most rational I can, and what appears so to them. Gravitation, or a centripetal tendency of Bodies is two-fold; first, a tendency towards the centre of the solar System; and, secondly, a tendency towards the centre of the Earth: the most obvious of which is the latter, and is evidently pointed out by all falling bodies; and the former as treated of and explain'd, in the Theory of the Sun. p. 231. of the Essays.

B.

B. How do they account for the cause of that centripetal tendency so obvious in all bodies; I mean, that tendency of all common matter towards the centre of the *Earth*?

A. From an exterior pressure of the universal elastic ætherial fluid, which visibly appears when we consider the Phenomena exhibited by falling bodies, I mean, those remarkable accelerations, which not only plainly point out the great violence of the force or *cause*, but are also plain indications that the cause of the gravity of bodies towards the centre of the earth is an exterior and impelling force, and not an inherent and essential property of matter, as hath been heretofore maintained by many others. The electrical Philosophers allow indeed, that to outward appearance the Cause of Gravity towards the centre of the Earth seems to be a real and essential property of *matter*, interwoven, as it were, into the very constituent parts of the matter of which our Bodies are composed. But nothing can be a plainer proof, that the *cause* of the gravitating tendency of all Bodies towards the centre of the Earth is an exterior force, than those accelerations of the motion of descending bodies. Besides, were the cause seated within the bodies themselves, their motion when descending must be more regular and uniform, consequently the accelerations are the effects of an external force (*a*).

(a) See p. 65. 66. on falling Bodies.

B.

B. As you are now speaking of the Cause of Gravity, you must excuse me if I claim your promise of recapitulating your Theory of the Nature and Office of the Sun.

A. I shall with pleasure fulfil my Engagement to you, and am inclined to hope, that if you consider my Theory with due attention, (for I will venture to call it mine, having never read or heard of it before) you may at length thank me for the Recapitulation, since it will explain to you in the most natural and clearest manner hitherto known, the true cause of the centripetal tendency of all the heavenly Bodies towards *their* Centre.

In the first place I must inform you, that the Dimensions of the Sun are briefly as follow: Diameter, 796400 English Miles, Circumference, — 2501970 English Miles, Area of the greatest Circle or Face of the Sun, 498142274784 square Miles.—Superficial Content, 1992569099136 square miles.—Solid content, 264479674235618688 cubical miles.

What a stupendous mass this! most exquisitely form'd and adapted to the Office for which it was ordained, and with no less than infinite Wisdom! And yet, when we take a general survey of the Works of the Creation, we find nothing made in vain; nothing superfluous or redundant; and notwithstanding this, all is perform'd (as Sir *Isaac Newton* has clearly demonstrated in his *Principia*) with mathematical exactness!

“ That



That so large a Body was created for Ends proportionably great cannot be doubted; and its very situation is no small indication of the same. What those ends are, though it may be impossible ever to find them all out, yet, by proceeding with due caution, we may very probably be able to obtain sufficient Data to conduct us to many useful Truths; and even when the Analogy appears true, and yet falls short of a Demonstration, it may then be put down by way of Interrogation or Quære, that the same nothing may be farther enquired into by others."

"The next remarkable Characteristic relating to that glorious Object, and which is almost obvious, are the Rays perpetually darting from him: This Phenomenon seems to indicate and point out his Office, viz. that of a Circulator. For, as hinted above, as he is every moment emitting his Beams from all parts of his Body, it may rationally be concluded, that he has constant a supply of the same elementary Fire will be thought absolutely necessary in order to preserve an Equilibrium."

"As in Mathematics there is no proceeding forward without proper Data, so it fares in Philosophy; unless the Problem hath sufficient Data, the Mathematician labours in vain; and can never investigate his Theorem; no more can the Philosopher without proper Requisites investigate his Theory."

"Arguing from Analogy is an approved method of investigating the Knowledge of Things.

Things. Now the Body of Man has been thought by some of the most curious Observers of Nature, to be analogous to the System of the World, and was therefore termed the Microcosm, or World in miniature, to distinguish it from the Macrocosm or great World. Let us then consider the Microcosm, which we best understand. This minute World we know to be composed of Solids and Fluids, and to be full of Motion; and also that the motion of the solid parts (and consequently that of the whole Machine) is from the effects of the motion of the bodily Fluids; for if their Motion be retarded in any degree, a proportionable defect is sure to follow among the solids also; and whenever their motion entirely ceases, the whole Machine becomes motionless, inanimate and dead."

"The next thing to be consider'd is the physical cause of this natural motion of the bodily Fluids;—which motion, we are well assured is performed by the Heart: An Engine or Instrument fitly contrived and adapted for that purpose, and placed in the most commodious part of the minute System for that End."

"If then, I say, the surest way to arrive at the Truth is to argue from Analogy, i. e. from Things well known, to those less known; the Macrocosm, or great World is also well known to consist of solids and fluids, and to be replete with a variety of Motions; which Motions,

from repeated observations appear to be owing to the effects of an active ætherial Fluid : This has been often conjectured before, and insisted on by some of the greatest and most eminent Philosophers, particularly Sir *Isaac Newton*, and Bishop *Berkeley* ; but as their Reasoning could never be sufficiently supported by proper Experiments before the late Discoveries by Electricity, the Evidences they produced were not properly regarded. ”

“ From the same method of Reasoning we are naturally conducted to the Sun, as a Circulator in the Macrocosm, which (as we find by the effects of those burning Mirrors) sends forth such plenty of a powerful ætherial Fluid, or pure elementary Fire. ”

“ Since then, by this method of Reasoning, we compare great Things with small, may not the Sun with sufficient Propriety be termed the *Cor Mundi*, or the Heart of the World, similar in its Office to the Heart in the Body, dispensing the ætherial Fluid to the utmost limits of the System ? Particularly, when we consider that such a constant emission of that ætherial Fluid from the Sun’s Body must require as constant a supply ; how that is performed I am now to enquire. ”

“ This Fluid, like the Blood in the Body, is from thence returned to maintain the Circulation : For as the Blood in the Microcosm is by the force of the Heart protruded to the utmost limits of the minute System, and when  
it



it can proceed no farther returns back to the Heart again to keep up and maintain the Circulation; so, if the Analogy holds good, the ætherial Medium in the Macrocosm when protruded to the utmost limits of the System of the World, and can proceed no farther, returns in like manner back to the Sun to maintain the Circulation; by what means such a Return is effected in the Macrocosm, I shall endeavour to shew."

"According to the modern Astronomy, every fixed Star is of the same Nature and performs the same Office that the Sun does in our solar System, which opinion is supported by many rational Arguments, some of which are the following."

"First, The Light of the fixed Stars is not a borrow'd Light, like that of the Planets; but innate, as that of the Sun."

"Secondly, Their distance is so immensely great, as to afford no perceptible annual Parallax, that is, so great that the distance of 162 Millions of Miles (equal to the diameter of the Earth's annual Orbit) nearer or farther from them, makes no sensible difference in their Altitude; neither does a celestial Telescope, which magnifies several hundreds of times, make any difference as to their magnitude, which are undoubted Indications that their distance is immensely great: And consequently,"

"Thirdly, If the Sun were placed at the same vast distance, it would appear like such

another lucid point,

“ Every fixed Star then, being allow'd to be the Centre of a System of Planets and Comets, performing the same Office as the visible Sun, and like that perpetually darting off its radiant Beams, to the utmost boundaries of each respective System and far beyond ; the consequence must be that the profound Abyss, or what is by some term'd the immense void, is most replete with Æther of all other parts, i. e. that part of Space, which we thought the most void and empty, contains the greatest fullness, and the densest Æther, i. e. the farther from those several grand Luminaries, the more dense it is conceived to be. ”

“ To render this yet more plain and intelligible, see Plate II. which will convey a more clear Idea than a multitude of Words : Where S, at the Centre represents the Sun : The 6 concentric Circles, the several Orbits of the Planets. The small Lines or strait Strokes, the solar Rays. The same is to be understood of all the surrounding solar Systems. ”

“ These Things considered, let us hear Sir *Isaac Newton* himself. “ Every Body, ” he says, “ endeavours to go from the denser part of the “ Medium towards the rarer ; And if this “ Medium be rarer within the Sun's Body than “ at his Surface, and rarer there than at the “ hundredth part of an Inch from its Body, “ and rarer there than at the fiftieth of an Inch “ from its Body, and rarer there than at the “ Orb

“ Orb of Saturn ; I see no reason why the increase of density should stop any where, and not rather be continued through all Distances from the Sun to Saturn and beyond. And though this increase of Density may, at great distances, be exceeding slow, yet if the elastic Force of this Medium be exceeding great, it may suffice to impel Bodies from the denser parts of this Medium towards the rarer with all that Power which we call Gravity. And that the elastic Force of this Medium is exceeding great may be gathered from the swiftness of its Vibrations.” Optics, Qu. 21.

“ These Things, though delivered as a Query, must be allowed to be his real Sentiments, as is manifest from the Advertisement in the 2d. and later Editions of his Optics, where he acquaints us, that “ to shew he did not take Gravity for an essential Property of Bodies, he had added one Question concerning its Cause, choosing to propose it by way of a Question, because he was not then satisfied about it for want of Experiments (a).”

“ Thus far Sir Isaac’s Opinion seems to coincide exactly with the present Plan. Since then it appears reasonable to suppose, that the farther the solar Rays proceed from him, the

(a) This therefore, for want of Experiments to prove it, we shall consider is in Theory only ; as we shall likewise the plurality of Solar Systems abovementioned, (notwithstanding it is an allow’d Doctrine) but it ought also to be considered that the latter corroborates and strengthens the former ; and especially, since it appears natural.



more dense they are, consequently, when they have gone on so far as to meet with those Rays from the nearest solar Systems around them, they must in those far distant Regions be densest of all. Is it not then natural to conclude, that at so dense a part of an extremely elastic Medium, it must from thence return again to the most rare part from whence it was sent, and in its progress, cause the centripetal Force of the Planets, i. e. that Force which causes them to gravitate towards the Sun? Hence a Circulation in the Macrocosm appears as agreeable to Reason, as a Circulation in the Microcosm; and that Gravity is performed by an impelling Force.—Is it not reasonable also to suppose, that such a gradual increase of the density of the *Æther* from the Sun to the utmost limits of the System, is the true mechanical Cause, why Saturn in the denser part of the Medium moves slower than Jupiter in a rarer; and again, Jupiter than Mars, Mars than the Earth? &c.”

“What a complete, glorious, and stupendous piece of Machinery then is the Solar System! How much more so is the whole frame of Nature! And how consummate the Power, the Wisdom, and the Goodness of the Divine and Incomprehensible Architect of the Universe!”

“Hence there appears a more general Cause of Motion in the World than what has been hitherto supposed, and an adequate method to render the centripetal Forces of the Planets and Comets intelligible and rational.” The

The Solar System then may not improperly be considered as a concave Sphere, where the greatest density or spring is conceived to be at the Surface or Circumference, and pressing from every individual part of it towards the Sun or Centre.—If Enquiries are pursued on this plan, they must necessarily terminate in an universal Plenum of the same elementary Fire.

## COHESION.

**C**OHESION, in Physicks, is the action whereby the Particles or primary Corpuscles, whereof natural Bodies consist, are connected or bound together, so as to form Particles; and those again kept together, so as to form several Masses or Bodies."

"The Cause of this Cohesion or nexus materiae has extremely perplex'd the Philosophers of all Ages. In all Systems of Physicks Matter is supposed originally to be in minute indivisible Atoms."

"How and by what Principle these several and distinct Corpuscles should come first joined and combined into little Systems; and how they should come to persevere in that state of union is a point of the most difficulty, and even of the most importance of any in Physicks?"

"The most popular Opinion is that so strenuously defended by J. Bernoulli *de gravitate Aetheris*,

a ~~Subject~~ *Subject*, who accounts for the *Cohesion* of  
 the parts of matter, from the uniform pres-  
 sure of the Atmosphere. Confirming this  
 Doctrine from the known Experiment of two  
 polished marble Planes, which cohere very  
 strongly in the open Air, but easily drop  
 asunder in an exhausted receiver. — But  
 though this Theory might serve tolerably well  
 to explain the *Cohesion* of compositions, or  
 greater collections of matter, yet it falls short  
 of accounting for that first Cohesion of the  
 Atoms, or primitive Corpuscles, whereof the  
 Corpuscles of hard Bodies are composed."

Sir Isaac Newton delivers his Doctrine of  
*Cohesion* thus: "The particles of all hard,  
 homogeneous Bodies which touch one and  
 other, *cohere* with a great Force; to account  
 for which, some Philosophers have recourse  
 to a kind of hooked Atoms, which in effect,  
 is nothing else, but to beg the thing in ques-  
 tion. Others imagine, that the particles  
 of Bodies are connected by rest, i. e. in effect,  
 by nothing at all; and others by conspiring  
 motions, i. e. by a relative rest among them-  
 selves. For myself, it rather appears to me,  
 that the particles of Bodies *cohere* by an at-  
 tractive Force; whereby they tend mutually  
 towards each other; which Force, in the  
 very Point of contact, is very great; at little  
 distances is less; and at a little farther dis-  
 tance is quite insensible. — Now if com-  
 pound Bodies be so hard, as by experience

we



we find some of them to be, and yet have a great many hidden pores within them, and consist of parts only laid together; no doubt those simple particles which have no pores within them, and which were never divided into parts, must be vastly harder."

"For such hard particles gathered into a mass, cannot possibly touch in more than a few points; and therefore much less force is required to sever them, than to break a solid particle whose parts touch throughout all their surfaces, without any intermediate pores or interstices. But how such hard particles only laid together, and touching only in a few points should come to *cohere* so firmly, as in fact we find they do, is inconceivable, unless there be some cause whereby they are attracted and pressed together."

"Now the smallest particles of matter may *cohere* by the strongest Attractions, and constitute larger, whose attracting force is feebler: And again, many of these larger particles *cohering* may constitute others still larger, whose attractive force is still weaker; and so on for several successions, till the progression end in the biggest particles, on which the operations in Chymistry and the Colours of natural Bodies do depend; and which by *cohering* compose Bodies of a sensible magnitude."

The different degrees of *Cohesion* constitute Bodies of different forms and properties.—

Thus the same great Author observes, the

‘ particles of fluids, which do not *cohere* too  
‘ strongly, and are small enough to render  
‘ them susceptible of those agitations which  
‘ keep Liquors in a fluid, are most easily sepa-  
‘ rated and rarefied into vapour, and make  
‘ what Chymists call *volatile Bodies*, rarefying  
‘ with an easy heat, and again condensing with  
‘ a moderate cold.”

“ Those, whose particles are grosser, and so  
‘ less susceptible of agitation, or *cohere* by a  
‘ stronger Attraction, are not separable without  
‘ a greater degree of heat, and some of them  
‘ not without fermentation; and these make  
‘ what the Chymists call *fixt Bodies*.”

See *Chambers* under the Word Cohesion.

Cohesion of the parts of matter is observed  
to be stronger or weaker according to the dif-  
ferent qualities of the adhering particles. The  
Cause of which Phenomenon was so intricate  
and perplexing as to be given up by Enquirers,  
even the most sagacious Naturalists, as impossi-  
ble to be accounted for on any natural or ra-  
tional Principles whatever. — And the Rev.  
Mr. *Jones* in his Essay on the First Principles  
of Natural Philosophy observes, “ that there  
‘ are a sort of Reasoners amongst us, who seem  
‘ to glory in their Ignorance, and have preci-  
‘ pitately defied all the Philosophers upon Earth  
‘ to account for the Cause of Cohesion, other-  
‘ wise than by the Power of the Deity imme-  
‘ diately interested.”

This being the case before the Discovery of  
Fire,

Fire, it may be well worthy our enquiry, whether some light may not be stricken out upon that subject, since a pure permanent Fire has been discovered. — It seems the more promising on account of our having discovered by electrical Experiments that this Fire is universal, not only in all open spaces, but exists in the pores of all Bodies. — Of the truth of this position we are certain; since it is undeniably proved by Experiments in general to be obtain'd from the pores of gross Bodies; and that which leaves us still less Reason to doubt is, that although it be real and true Fire, yet we obtain it with the greatest ease and in the greatest plenty, from nothing (Metals excepted) so much as from Water.

The Cohesion of Matter, or what we term Solidity is very different in different Bodies, some cohering much stronger than others, which differences prevail even among Bodies belonging to the same class, as for Instance in Metals.

In the 3d. part of my Essays, p. 441. when treating on Cohesion, 'tis observ'd that the most effectual method to obtain a true Idea of the Cause of Cohesion is by means of a previous enquiry into the manner by which the strongest Cohesions may be destroyed. To effect which, it is necessary to premise what we find confirmed by a variety of electrical Experiments, particularly by many that are contain'd in Chap. 3d. of the 1st. part; viz. that of a



subtile Medium existing in the pores of all gross Bodies, which Medium when obtain'd from their pores by means of the electrical Apparatus is found to be real and true Fire; so that, as is there observ'd, in the melting of metals, there is no more fire introduced into them than was before; all that seems requisite to destroy the Cohesion is only to communicate a sufficient degree of heat to the component parts of that fire already in their pores: Accordingly we find, that as soon as such a heat is communicated to it, the particles of the fire contained in the pores become so expanded, that the particles of the metal become separated from one another, i. e. a fusion ensues: But no sooner is the violence of the heat a little abated, and by that means the expansion of the particles of the internal fire lessen'd, than the former coalition of the gross particles begins to take place again, and as the heat more and more decreases, that expansion being thereby more and more contracted, the Cohesion becomes again more and more complete. Or it may otherwise be thus defined: *the Cohesion*

The *Pneuma, Essence, or Spirit* of Lord Bacon, that elastic pressing Agent, which we find by Experiment to be constantly descending from the upper Regions to the Earth in general, and to all rarefied parts in particular, is the real Cause why Bodies descend with such Force, and why the parts of the metal coalesce before and after the fusion, which violent and pressing

the pressing Force of that Agent is yet overcome by the more violent contracting Force of the expanded fire in the pores of the Metal, when so intensely heated, i. e. the violent intumescent or expansion of the heated Fire in the pores of Metal, overcomes the elastic Pressure, even of that very Pneuma, ( which before caused the parts to cohere ) and by that means bears it away from the Metal; this seems clear, since a fusion immediately ensues, and continues so long as the same heat continues; but as before observed, when the heat and consequently the expansion of the internal Fire lessens, the Cohesion again commences, and increases in the same proportion.

To illustrate this Doctrine. The six Metals are found to be endued with six different degrees of firmness, and require as many different degrees of heat to melt them, i. e. to destroy their Cohesion; of which in their order.

*First.* Tin being of the most loose texture, let the degree of heat which is sufficient to melt it be called one. — as the Metal cools the Cohesion again commences, and when cold, the Cohesion is then perfect.

*Second.* Lead, being more compact, requires two degrees of heat to destroy the Cohesion; as this cools the Cohesion commences as before.

*Third.* Silver, being the next in order, requires three degrees of heat to destroy the Cohesion.

*Fourth.*

*Fourth.* Gold, the adhesion of the constituent parts of which being still more tenacious, requires four degrees of heat to destroy the Cohesion.

*Fifth.* Copper, requires a still greater heat to fuse it.

*Sixth.* Iron, being the hardest of all Metals then known, requires the greatest degree of heat of all others to destroy the Cohesion.

Or otherwise by way of illustration and if possible to render it still more plain and intelligible.

Quicksilver having of late Years been discovered to be capable of being frozen, (a) and by that means rendered a perfect Metal, we have now seven complete Metals. And if we were for once allowed to call Ice a Metal, the number would be eight and nearly in the following order; viz. Frozen Quicksilver, Ice, Tin, Lead, Silver, Gold, Copper, and Iron, and would require eight different degrees of heat to destroy their Cohesion.

*First.* Let the degree of heat which destroys the Cohesion of the frozen Quicksilver be called one degree. — it would then be easy to conceive that to cause the Particles to cohere again, no more would be required than to take away that small degree of heat.

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(a) Frozen by means of an artificial Cold. — This discovery was made at Petersburg. For the manner of the discovery and process. See my Essays Pages 249, 250 et seq.

*Second.*



*Second.* Ice, which requires a greater heat to destroy the Cohesion, may be called two degrees. If then one of those degrees be taken away the Cohesion is restor'd again.

*Third.* Tin requires three degrees of heat to destroy the Cohesion; if one of which be taken away, the Cohesion would again commence.

*Fourth.* Lead requires four degrees of heat to destroy the Cohesion, one of which being taken away, the Cohesion takes place as before.

*Fifth.* Silver requires five degrees of heat to destroy the Cohesion, one of which being taken away the Cohesion is restored.

*Sixth.* Gold requires six degrees of heat to destroy the Cohesion, which immediately returns on the removal of one degree thereof.

*Seventh.* Copper requires seven degrees to destroy the Cohesion, which is restored on the withdrawing one degree of the heat.

*Eighth.* Iron requires eight degrees of heat to destroy the Cohesion, but if one be taken from it, or it be lessen'd, the Cohesion in the same proportion returns.

Thus Fire is continually dissolving some Bodies, which a little before in a smaller degree of heat appear'd of a solid consistence.

Hence we have obtained the Cause of Cohesion, and the manner how it may be destroy'd, in a variety of Cases, which may be sufficient to illustrate and point out the cause of other Cohesions, particularly, since we are certain that a sufficient degree of heat will destroy the strongest,

strongest, as will be found by consulting the indefatigable *Boerhaave's* account of *Kilner's* Mirror.

“ That concave Speculum, or solar Burner, in a minute's time, melted all the six Metals, also all the semi-metals that have been hitherto tried : Even stony and rocky Bodies are melted and vitrified by it in an instant ; as are Bricks, Clay, Sand, Crucibles, Marble, Jasper and Porphyry, which are turned into Glass by it. And lastly, the very stones, which the Masons make use of for Building the Furnaces designed for the fusing of Iron, and separating it from its vast hard fossil Ore, melt and vitrify in this focus immediately ; which no Person, let him understand these things ever so well, or let him have seen ever so much of the violence of confin'd Fires, could ever have imagined ; for these same Stones would have remained many Years without alteration in the intense Fire to which these Furnaces are always exposed : So that the Power of this focal Fire is able to effect that in the least instant of time, which the other, though the strongest we know of besides, could hardly accomplish in the space of some Years.” See *Boerhaave's* Chym. vol. I. p. 134. *Dallowe's* Translation : or my Philosophical Essays, part II. page, 220. Sect. 102.

Having treated of the above several Metals, and the different degrees of heat required to destroy

destroy their Cohesion; and since the Discovery of a method for the freezing of Quicksilver, the number of perfect Metals, which before were 6, was thereby augmented and became 7, I shall now beg leave to offer to your consideration a few hints on the very extraordinary and singular Properties of a new Metal called *Platina* or white Gold; (a) their number is therefore now become 8, of which 8 Metals one of the two last added to their number is the most easily fusible, and the other the most hard and difficult of all others. The very imperfect Knowledge of the Properties of this extraordinary Metal, till within these few years, appears to be owing to the great difficulty which is found of destroying the Cohesion so as to bring it to a fusion: This was attempted by different methods, and has been found to withstand the force of the most intense and continued Fire

(a) *Platina* is in small and pretty smooth grains, most of them resembling, as to their figure, pyramidal Triangles with blunted points; their colour not much unlike that of coarse filings of unrudded Iron, but approaching nearer to a silvery whiteness after being soaked in an acid, or heated to a high degree. Mr. *Macquer* supposes with great probability, that the Metal owes its name to this last property, as derived from the word *Plata*, which in Spanish signifies Silver.

The name of *white gold*, which has likewise been given to this metal arises out of certain properties, which also belong to gold, such as to be nearly of the same specific gravity as gold; to resist like that the action of Sulphur, Lead, Antimony, the royal Cement, and all pure Acids; and to submit like gold, to no solvent but *Aqua-regia*, and *Hepar sulphuris*.



of the Chemists without much alteration : No Heat was yet discover'd sufficient for the purpose, till one more active than the rest was thought of, which when properly applied was found to effect a complete fusion : The Agent I mean is that of the *Solar Fire* collected in the focus of a burning glass, by which means it was fused, and thereby render'd a perfect metal, no metal being truly perfect till it is so malleable as to spread under the hammer : This was discover'd by that ingenious Chemist Mr. *Macquer*, of the French Academy, and may be found in his chemical Dictionary under the word *Platina* : So that with the addition of this metal, together with that of water, we have nine Bodies in form of Metals, which will require nine different degrees of heat to destroy, and as many to restore their respective Cohesions.

### On MAGNETISM.

**H**AVING in the briefest manner treated, First, on the Cause of Motion : Secondly, of Gravity : And Thirdly, of Cohesion : I shall next endeavour, in the same brief manner to shew the Cause of Magnetism : But the Phenomena exhibited in Magnetism are more untractable and difficult than either of the former ; and the cause, or rather the manner or mode of its acting seems farther out of our reach.

There can be, however, little doubt, but that

that the Phenomena are effects produced from the same cause in a different mode or dress: In that form it appears more subtle and active than in any other. This was the reason of my calling it Spirit of Æther, and using Lord Bacon's appellation, *Pneuma*.

My first hint concerning the cause of Magnetism was from the Phenomena afforded by vertical Bars of Iron, which, by means of that position, were observed to acquire a magnetical virtue. That Phenomenon seem'd first to be taken notice of by Mr. Boyle. See his Philosophy, abridg'd by Mr. Shaw, Vol. I. p. 498.

A Recapitulation of the Experiment may be seen in a Note. See Essays, p. 78. sect. 158. and p. 407. where that Author, after speaking of the Magnetism acquired by the iron Bars of Windows, or any other that have stood a considerable time in a vertical position, says, " I have found, indeed, that if a Bar of Iron; which has not stood long in an erect posture, be but held perpendicular, the same Experiments will succeed; but then this virtue, display'd by the extrems of the Iron, will be so transient, that if the Bar be but inverted, and held again upright, that end which just before was uppermost, and drew the north point of the Needle, will now, being lowermost, drive it away; which will not happen to a Bar that has been for some years kept in that position."

From various Observations nothing can appear

pear much more obvious and plain than that Magnetism is acquired by means of a most subtile active fluid, which pervades the pores of those iron vehicles, and which are capable not only of acquiring by that means a magnetism themselves, but likewise of communicating a still greater magnetism to other iron Bars, which will more plainly appear a little farther on, when I come to treat of the manner of the construction of artificial Magnets.

According to former observations, Motion, Gravitation, Cohesion, &c. are all of them different Phenomena produced by the same identical cause; and no reasonable doubt can be made but that the cause of magnetism is the same universal subtile elastic *Æther*, acting in a still different form. That the magnetic virtue, the electrical virtue, the Fire of Lightning are all of them one and the same Principle, under different forms, cannot be reasonably doubted, since the effects from each are the same; magnetic polarity, for instance, is evidently generated in iron Bars by means of the subtile elastic fluid constantly passing through them.

*Dr. Franklin* has presented us with a method to give such a polarity to common Needles as to cause them to traverse when laid on water; and informs us that it was a frequent Experiment at Philadelphia to give a polarity to Needles by only passing the electrical flash through them. — So that the same effects are produced by



by a flash of electrical Fire as from a flash of Lightning. — By flashes of Lightning Capt. *Waddel's* Compasses either lost the virtue of the Loadstone, or else the poles were reversed, the North point turning towards the South. — We are now, however, demonstrably certain, that we were egregiously mistaken, when we imagined every Magnet to be endued with Poles, an Axis, and an Equator, in a similar manner with the Earth itself. I shall therefore desist from any farther enquiry into the nature of it, leaving it to the explanation of Time and Experience; and shall conclude this account of natural Magnets with what is, if possible, yet more abstruse and unintelligible, viz. the manner of constructing artificial ones.

## ARTIFICIAL MAGNETS.

**T**HERE have been several methods proposed for making artificial Magnets; but none has yet met with greater Success than that of Mr. *Canton*, a Gentleman well known to the learned world, and to whom we owe the Discovery.

**The Process.** — “Procure a dozen of Bars, six of soft Steel, each to be three Inches long, one quarter of an Inch broad, and one twentieth of an Inch thick; with two pieces of Iron, each half the length of one of the Bars, but of the same breadth and thickness; also six pieces of hard Steel, each five Inches

and

and an half long, half an Inch broad, and  
 three twentieths of an Inch thick ; with two  
 pieces of Iron of half the length, but the  
 whole breadth and thickness of one of the  
 hard Bars ; and let all the Bars be marked  
 with a line quite round them at one end.  
 Then take an iron Poker and Tongs, or two  
 Bars of Iron, the larger they are and the  
 longer they have been used, the better ; and  
 fixing the Poker upright between the knees,  
 hold to it, near the top, one of the soft Bars  
 (having its marked end downwards) by a  
 piece of sewing Silk, which must be pulled  
 tight by the left hand, that the Bar may not  
 slide ; then grasping the Tongs with the  
 right hand, a little below the middle, and  
 holding them nearly in a vertical position,  
 let the Bar be stroked by the lower end from  
 the bottom to the top, about ten times on  
 each side, which will give it a magnetic  
 Power sufficient to lift a small key at the  
 marked end (*a*) ; which end, if the Bar was  
 suspended on a point, would turn toward the  
 north, and is therefore called the north Pole,  
 and the unmarked end is for the same reason  
 called the south Pole. Four of the soft Bars  
 being impregnated after this manner, lay the  
 two, parallel to each other, at the distance of  
 one fourth of an Inch, between the two  
 pieces of Iron belonging to them, a north

(*a*) Here the Tongs and Poker may be put by as useless,  
 there being no farther occasion for them in the Process.

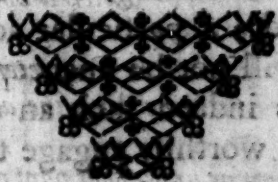
and

and a south Pole against each piece of Iron ; then take two of the four Bars already made magnetical, and place them together, so as to make a double Bar in thickness, the north Pole of one even with the south Pole of the other ; and the remaining two being put to these, one on each side, so as to have two north and two south Poles together : Separate the north from the south Poles at one end, by a large pin, and place them perpendicularly with that end downwards on the middle of one of the parallel Bars, the two north Poles towards its south, and the two south Poles towards its north end : Slide them backward, and forward, three or four times the whole length of the Bar, and removing them from the middle of this, place them on the middle of the other Bar, as before directed, and go over that in the same manner ; then turn both the Bars the other side upwards, and repeat the former operation ; this being done, take the two from between the pieces of Iron, and placing the two outermost of the touching Bars in their room, let the other two be the outermost of the four to touch these with ; and this Process being repeated till each pair of Bars have been touched three or four times over, which will give them a considerable magnetic Power ; put the half dozen together after the manner of the four, and touch with them two pair of the hard Bars placed between their Irons, at the distance of about  
half



half an Inch from each other ; then lay the soft Bars aside, and with the four hard ones let the other two be impregnated, holding the touching Bars apart at the lower end near two tenths of an Inch, to which distance let them be separated after they are set on the parallel Bar and brought together again before they are taken off : This being observed proceed according to the method described above, till each pair have been touched two or three times over ; but as this vertical way of touching a Bar will not give it quite so much of the magnetical virtue as it will receive, let each pair be now touched once or twice over in their parallel position. between the Irons, with two of the Bars held horizontally or nearly so, by drawing at the same time the north of one from the middle over the south end, and the south of the other from the middle over the north end of a parallel Bar ; then bringing them to the middle again without touching the parallel Bar, give three or four of these horizontal strokes to each side. The horizontal touch after the vertical will make the Bars as strong as they possibly can be made, as appears by their not receiving any additional strength when the vertical touch is given by a great number of Bars, and the horizontal by those of a superior magnetic Power. This whole Process may be gone through in about half an hour ; and each of the large Bars, if well hardened, may

• may be made to lift twenty eight Troy Oun-  
 • ces, and sometimes more. And when these  
 • Bars are thus impregnated, they will give to  
 • an hard Bar of the same size its full virtue in  
 • less than two minutes; and therefore will  
 • answer all the purposes of Magnetism in Na-  
 • vigation and experimental Philosophy much  
 • better than the Loadstone, which is known  
 • not to have a sufficient Power to impregnate  
 • hard Bars. The half dozen being put into a  
 • case, in such a manner as that two Poles of  
 • the same denomination may not be together,  
 • and their Irons with them as one Bar, they  
 • will retain the virtue they have received; but  
 • if their Power should, by making Experi-  
 • ments, be ever so impaired, it may be re-  
 • stored without any foreign assistance in a few  
 • minutes. And if, out of curiosity, a much  
 • larger set of Bars should be required, these  
 • will communicate to them a sufficient Power  
 • to proceed with, and they may in a short  
 • time, by the same method, be brought to  
 • their full strength.





A. \*\*\*\*\* HAVING thus far extended  
\*\*\*\*\* my Enquiries into the Nature,  
\*\*\*\*\* H \*\*\*\*\* Properties and Uses of Fire, in  
\*\*\*\*\* order to evince it to be an *uni-*  
\*\*\*\*\* *versal* Agent in the strictest  
Sense of the Word, and the true physical Cause  
of the several Phenomena of Nature before re-  
cited, which have been long since given up as  
inexplicable by any philosophical Principles  
hitherto known, I must inform you of one  
thing more relating to Electricity, which I  
cannot omit, it being of a most singular na-  
ture, and manifestly tending to confirm the  
doctrine of the Universality of this electrical  
Fire. But here I imagine that you will be  
greatly surpris'd, as I was myself, at such un-  
expected Effects from a most simple Apparatus;  
an Apparatus consisting of nothing more than  
a pair of Stockings.

These Experiments have been presented to  
the World in several Papers read before the  
Royal Society by *Robert Symmer Esq; F. R. S.*  
And, as they illustrate my present subject, are  
curious and entertaining, and, I believe, but in  
very few hands; a particular account of them,  
I presume, will not be unacceptable to you.

B. This is indeed such an unheard of No-  
velty as will worthily engage the Attention of  
the curious.

A. You will have just Reason to think so,  
if



if you will have patience to hear the ingenious Author's own Narration of his Experiments.

B. I should think I possess but a very small share of Curiosity were it not excited by such an extraordinary account as the electricity of Stockings. The following is a Transcript of those Papers.

## P A P E R I.

Read February 1st. 1759.

"I had for some time observed, that upon pulling off my Stockings at night, they made a crackling or snapping noise; and in the dark I could perceive them to emit sparks of Fire: I made no doubt but that this proceeded from a principle of Electricity; and I was confirmed in this Opinion, by observing, that, in Weather favourable for electrical Experiments, those Appearances were more remarkable than at other times. I mentioned this Observation to several of my Friends, and some of them told me, they likewise had often perceived the snapping and emission of Fire from their Stockings upon pulling them off, especially in the Winter nights: But I could not hear of any Body that had taken this Phenomenon into Consideration in a philosophical way. For my own part, I could not but think, that so striking an appearance, one that seems to have an immediate connexion with the human Body, or is at least as much about us as the Cloaths we wear,

and is obvious to the perception of our Senses, merited not only a philosophical attention, but the strictest Enquiry possible.

I was the more induced to such an enquiry, as it seemed to me to open a new path for proceeding in electrical Researches, and might perhaps throw new light on the great and surprising discoveries already made in that branch of natural Philosophy. The simplicity of the Apparatus, and great facility in making the proper Experiments, putting it in my power to begin and carry on my enquiry at pleasure, I entered upon somewhat of a regular course of observations about the beginning of November last; and since that time have pursued it as closely as my Leisure and the Weather, which has been far from favourable for electrical Experiments, would permit. It is the purpose of this, and of those Papers that may follow, to lay before the Royal Society an account of the Experiments and Observations I have already made, or may hereafter be able to make, in the progress of this enquiry.

My first endeavour was to discover what sort of Stockings was most proper to produce Electricity, in order to determine this, I tried single Stockings of different kinds, viz. Thread, Cotton, Silk and Worsted, putting them on, and wearing them some time. On pulling them off, I could perceive nothing of Electricity in the Thread or Cotton, and no remarkable

ble degree of it in the Silk and Worsted.

When I say, *no remarkable degree of it*, it may be proper to be a little more explicit. I must therefore observe, that Silk and Worsted, being in themselves electric, are both of them, especially Silk, extremely susceptible of Electricity. I have sometimes observed, particularly when the Weather was favourable, that Silk when but barely handled, nay, when but simply touched, has become electrical where it had been handled or touch'd, as appeared by its attracting little light Balls suspended by Threads. It cannot therefore be supposed that Silk or Worsted Stockings can be put upon the Leg, without being excited to a sensible degree of Electricity. And thence it is, that when taken off they are sometimes perceived to snap though worn single. But whatever Electricity the single Stockings acquires by friction or otherwise, it immediately loses it upon being separated from the Leg: If any electric virtue remains, it is no more than what belongs to it as an electric substance ceasing to be excited; and it is in so small a degree, as in the present case not to merit attention. In general, when I speak of the Electricity in question, I mean such a Power of Electricity as is obvious, and perceptible to the senses, so that the Stockings, after being taken off, should appear more or less inflated; throw out an electrical Wind to be felt by the bare Leg; attract or repel another Stocking

visi-



visibly; and, upon the touch, snap and emit or receive electrical Fire.

After making the Experiment above-mentioned with single Stockings, I proceeded to try the effect of two Stockings upon one Leg. This I did with two of thread, cotton, worsted, and silk successively; but this produced no electrical appearance more than before. I then combined them one with another, and, running through all the different changes, I found that none of those I then made use of exhibited visible proofs of Electricity, but the silk and worsted together; and there, indeed, the electric power appeared remarkably strong. It seemed to be a matter of indifference whether the silk or the worsted were uppermost, the combination of the two was what I judged to be essential; and happening at that time to wear silk Stockings with thin worsted under them, I kept to the use of these, and found it a convenient Circumstance in the course of my Experiments.

As some may have the curiosity to examine the Observations I present them with, by Experiments of their own making; before I proceed further, I shall furnish them with a few Remarks, which may enable them to make their Experiments with more ease and certainty than if they set out unacquainted with some Circumstances, which I have learnt from Experience.

One of the first things to be attended to is the

the weather, which has an Influence on all electric Experiments, but upon none more than those which relate to this branch of Electricity. The most favourable weather is that which is dry and clear, and if a little frosty, so much the better. In general, when the quicksilver in the Barometer rises, and the Fire burns remarkably brisk and clear, we may expect a considerable appearance of Electricity; at other times, it is better not to attempt the Experiment.

When the Weather is favourable, it is not necessary to wear the Stockings all day: That, indeed, raises the electrical Power to the highest degree; yet, provided they be dry and made warm by the Fire, before they are put upon the Leg, their continuance upon it for a short time prepares them sufficiently for exhibiting visible Proofs of Electricity. If this should not answer upon the first trial, the Operation may be repeated two or three times to bring them into a proper disposition to receive the electrical virtue; and this is no more than what is found to be sometimes necessary with respect to glass Globes and Tubes, especially when new. If the Stockings have once acquired this disposition, they retain it for the day, or until a change of weather, and the Experiment may be repeated with success as often as one pleases; for no sooner are they discharged of their Electricity, than they are ready to receive it anew; nay, if speedily returned upon the Leg, they catch.

catch it instantaneously, and may be immediately pulled off to exhibit a new explosion: What is still more surprising, they seem to gather force by the frequency of the repetition, and, to some certain degree, increase in electrical Power, provided they be all along kept warm and dry, and that the Leg continue warm.

Another Circumstance to be carefully attended to is the manner in which they are to be taken off; for as to the putting them on, it is a matter of indifference how that is performed. In taking them off, care must be had not to separate them; for if that happens in pulling them off, all the Electricity escapes. The best way is to put the hand between the leg and the stockings and push them off together. Nothing more remains to be done than to pull them asunder; for upon that, they both of them exhibit a degree of Electricity, which, when at the highest, is really surprising.

Before I conclude these occasional Remarks, it may not be improper to observe, that it is not absolutely necessary that the Stockings be applied to the bare Leg; if a fine thread stocking separate them from the leg, though left upon it when they are taken off, it does not much impair their Electricity. But it is more convenient to use the hand instead of the leg. The insertion of the hand into the stockings is alone sufficient, especially in favourable weather, to communicate such an electric Power as renders



them capable of answering expectation in such Experiments as I have occasion to make.

~~(a) I now return to my subject.~~

The Opinion I had conceived, that the combination of silk and worsted was necessary for the production of Electricity, seemed to meet with confirmation from all the Experiments I made with the Stockings I then wore. I was at that time in mourning, so that my silk Stockings were black, and under them I constantly wore thin white worsted. About the latter end of November I went out of mourning, and of course changed the colour of my Stockings. On the second of December, having put on a pair of white silk above the worsted, after I had wore them some hours, I resolved to amuse myself with a few Experiments. The Weather was remarkably favourable, and I had reason to expect a fine appearance of Electricity; but upon taking off my Stockings, and pulling them asunder, to my great astonishment, I found they discovered no signs of electrical Power: As I held them in my hands they hung down collapsed, and did not more attract one another than before they were put upon my leg. I repeated the Experiment two or three times, but with no better Success.

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(a) An Improvement may perhaps be made upon this, by getting a piece of Silk or Worsted, knit, or wove in a Stocking Loom, so that without being cut it may be formed into the shape of long Mittens or Sleeves, or rather what we call a silk or worsted Tube, &c.

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An Event I so little expected, disconcerted me much. I saw I was no longer to ascribe Electricity to the combination of silk and worsted; but I remained at a loss to know to what I *should* ascribe it. At last, upon considering the Circumstance of this and other Experiments, a conjecture occurred, that the Electricity in question might depend upon the nature of different colours. In order to determine this, I thought it fairest to make the trial in the same substances. Accordingly I had recourse to the following Experiment.

I took a pair of white silk Stockings, and having warmed them at the Fire put them both upon the same leg. After I had worn them about ten minutes, I took them off, and pulled them asunder, but discovered no signs of Electricity in either. I did the same with a pair of black silk, but to no other effect. I then proceeded to the decisive trial. I put a black and a white Stocking upon my leg, and wore them likewise ten minutes. I waited with some impatience to see the success of my Experiment, and in return had the satisfaction of observing, upon their being pulled asunder, that each of them had acquired a stronger degree of Electricity than I had before seen; they were inflated so much, that each of them shewed the entire shape of the leg, and at the distance of a foot and an half they rushed to meet each other. I went through the same Experiment with worsted Stockings, and found that,

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as in silk, nothing but the combination of black and white produced Electricity. As I had often experienced the Power of Electricity in the combination of black silk with white worsted Stockings, there remained to try but that of white silk with black worsted, which answered as I expected, and seemed to complete the Demonstration.

A Phenomenon so new, and of so curious a nature as these Experiments presented, could not but for some time engage my attention."

## P A P E R II.

Read May 17th. 1759.

"**I**N my former Paper, I gave the Society an account of some Experiments made with silk and worsted Stockings, by which it appeared, that the remarkable degree of Electricity they had acquired by being put upon the leg depended on their being of different colours, namely, black and white. I did not then, nor do I yet take upon me to determine the cause of this Phenomenon. Whether it be owing to light, which is the origin of colours, or only to the ingredients which enter into the composition of several Dyes; or to those conjunctly with the colours they produce; in any of these views the matter is curious, and equally merits a careful enquiry.—But I fear the solution of this, and of many other difficult



cult questions concerning Electricity will depend upon the establishment of a more perfect Theory than we have yet attained to. Till we shall be so fortunate as to discover the Nature and Properties of the Powers employed in these Operations, we must be satisfied to pursue the path of Experiment and Observation in quest of those, as first Principles. This is the method I shall continue to follow; and having already shewn the manner of electrifying the black and the white Stocking, it is now my purpose to give an account of the Appearances and Powers of that Electricity so excited.

Having made a great number of Experiments since I had the honour of presenting my former Paper to the Society, I have had an opportunity of observing, that the Electricity produced between black and white silk is stronger than that between silk and worsted of those different colours, and a great deal stronger than that between worsted and worsted; the last is so weak, except in time of frost, or when a sharp north-east wind blows, that though the effects are always of the same nature, yet they are sometimes so languid as to be scarce perceptible. I shall therefore, and for the sake of brevity, confine myself in this Paper to what is observable with regard to the Electricity between black and white *Silk*.

It is proper to mention another Circumstance: Having found it troublesome to electrify the Stockings by putting them as often on my leg

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as was requisite in making Experiments, I have quitted that method entirely, and satisfy myself with the degree of Electricity which is excited in the Stockings by drawing them upon my hand; and this is to be understood with regard to all the Experiments and Observations I may have occasion to mention, unless when otherwise expressed. The Electricity thus produced is not always equally powerful with that which is excited by means of the leg; but it is nevertheless sufficiently strong to answer all the purposes in view; and it is attended with this advantage, that the Stockings continue longer fit for these Experiments; for like other electrical Apparatus's, they must be kept clean and free from all extraneous matter; and are therefore most to be depended upon when new, or when newly washed.

To give a distinct account of the Electricity of black and white Silk, I shall trace it through its whole process, beginning before the Stockings of the different colours are put together.

After being a little aired at the Fire, when the black silk is drawn upon the hand, a crackling noise is heard; and in the dark sparks of Fire may be perceived as passing between the hand and the stocking: While it is drawn backwards and forwards the crackling continues, and is most considerable upon the separation of the stocking from the hand. Thus it appears, that black silk is highly susceptible of Electricity; that it is produced almost instant-

stantaneously, or at least with very little friction; that most of it escapes, while the stocking is yet upon the hand; and that upon the total separation very little remains. This is similar to what happens with the glass Tube, when the hand, after passing along it in one direction repasses it in the other. But still the Electricity that the Stocking retains, after it is separated from the Hand, is considerable enough to attract or repel little light Bodies at the distance of one or two Feet: Some degree of inflation in the Stocking is likewise perceivable; and when a non-electric is brought near it, a crackling is heard, and in the dark sparks may be seen. If two black stockings be drawn upon the same hand at a time, the appearances are much the same as before; only that the stockings, when taken off and separated, give smaller proofs of Electricity, than if each of them had been single upon the hand.

Having found it necessary, as I proceed in my course of Experiments, to fix upon some method of ascertaining the principal appearances of Electricity, and marking the degree of it, I had recourse to the little pocket Electrometer of Mr. *Canton's* Contrivance, which is described in Vol. XLVIII. No. 93. of the Transactions of this Society. When this Instrument is supported by glass, it not only shews the attraction and repulsion, in general, of electrified Bodies, which is one of the most essential properties



erties of Electricity, but it distinguishes between the positive and negative state of Electricity, according to reciprocal attraction or repulsion of little balls. By the terms *positive* and *negative*, I mean only to denote the opposition of two different states. The particular allotment of the one or the other term appears to me to be arbitrary ; but that I may not differ unnecessarily from others, I shall apply the word *positive* to that state in which a Body is found to be when electrified by the clear glass Tube rubbed by the hand, and the word *negative* when electrified by the rough or opaque glass Tube of Mr. Canton's Invention (described in the Transaction mentioned above) when rubbed in the same manner, or by sulphur or wax excited. In other words, when the Body is in a state of repulsion with the former of those Tubes, we say it is *positively* electrified, and *negatively* when in a state of repulsion with the latter, or with sulphur or wax.

Nothing appears to be more wonderful than this double state : Here Electricity seems to counteract itself, the electrified Body attracting in one what it would repel in the other case, and *vice versa*. As this remarkable Property may be traced in its consequences through almost all electrical appearances, I cannot but think it merits great attention, and, when it comes to be better understood, may throw much light upon the System of Electricity. However that may be, it was impossible for

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me to observe, that it runs through the whole of that branch, which I have at present under Examination, and to which I return.

White Silk differs much in Electricity from black Silk. When the white Stocking is drawn separately upon the Hand, no crackling is heard nor sparks of Fire seen in the dark, let it be pulled backwards and forwards ever so often: when another white Stocking is drawn on above it nothing more appears; and when separate from the hand, neither of them discovers any signs of Electricity, excepting, that when brought within a few Inches of the Electrometer, they attract and repel the balls a little.

If, instead of two white or two black stockings, one white, and over that a black stocking be drawn upon the hand, they discover not the least signs of Electricity while they continue upon the hand, even though they should be drawn backwards and forwards upon it several times; nor when taken together from the hand and presented to the Electrometer do they appear to have acquired any more than a small degree of Electricity. They must be brought within the distance of a foot, nay, sometimes of a few inches, before they have any effect upon the balls; but the moment they are separated, they are found to be both of them highly electrified, the white *positively*, and the black *negatively*. The Circumstances that appear the most to merit Observation are as follows:

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*First.* When the Electrometer is placed on a non-electric, and the black stocking is presented to it at the distance of three, four, or five feet, according as it happens to be more or less powerfully electrified, the balls begin to be visibly attracted, and when it is brought nearer, they are seen to be agitated in a violent manner. If, instead of the black, the white Stocking be presented at the same distances, it is found to have precisely the same effects, attracting and agitating the balls in the very same manner : From whence it appears, that whatever difference there was between the Electricity of the black and the white, under other circumstances, they each of them acquire an equal degree of Electricity, by being electrified together.

*Secondly.* When the Electrometer is supported by glass, and the white Stocking is presented to it, it first attracts the balls, and afterwards repels them; when taken away, it leaves them in a repulsive state with regard to each other; when brought back, it repels them as before. If, in place of the white, the black be now presented, the balls are immediately attracted, soon after again repell'd, and left once more in a repulsive state with regard to each other. If the white be again presented, the same train of effects takes place as before; and so on alternately, as in the case of the clear and opaque glass Tubes when excited; the white Stockings answer precisely to the clear, and the black to the

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opaque tube, and acting, the one *positively*, the other *negatively* at full as great a distance, and as forcibly as the tubes.

*Thirdly.* Both the Stockings, when held at a distance from one another, appear inflated to such a degree, that, when highly electrified, they give the entire shape of the Leg; and when brought near the Face, or any naked part of the Body, there is a sensation felt, as if a cool wind was blown upon that part. When the two white, or two black are held together by the extremities, they repel one another, and form an angle, seemingly of 30 or 35 degrees.

*Fourthly.* When a white and a black Stocking are presented to each other, they mutually attract, with a force answerable to the degree of Electricity they have acquired: when brought within the distance of three feet, they usually incline towards one another, within two and an half, or two feet they catch hold of each other; and when brought nearer, they rush together with surprising violence. As they approach, their inflation gradually subsides, and their attraction of foreign objects diminishes: When they meet, they flatten, and join as close together, as if they were so many folds of silk; and then the balls of the Electrometer are not affected at the distance of a foot, nor even of a few inches at certain times. But what appears most extraordinary is, that when they are separated, and removed at a sufficient distance from each other, their Electricity does not appear

pear to have been in the least impaired by the shock they had in meeting. They are again inflated, again attract, and repel, and are as ready to rush together as before (*a*). When this Experiment is performed with two black Stockings in one hand, and two white in the other, it exhibits a very curious spectacle: The repulsion of those of the same colour, and the attraction of those of different colours throws them into an agitation that is not unentertaining, and makes them catch each at that of its opposite colour, at a greater distance than one would expect. When allowed to come together they all unite in one mass; when separated they resume their former appearance, and admit of the repetition of the Experiment as often as you please; till their Electricity, gradually wasting, stands in need of being recruited.

*Fifthly.* When they are separated from one another, they lose their power very soon, much as the excited Tube does; but when they are together they will retain it for an hour or two

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(*a*) The Phenomena, here remarked, of the black Stocking and the white when electrified, namely, that as they approach one another, their attractive and repulsive force decrease with regard to foreign objects, but increase surprisingly with regard to each other, and that their Electricity suffers no diminution from the shock of their congress appear to me to be observations new in Electricity, and to merit attention. They seem to point out a retentive power of Electricity, which takes place between electrics, and electrics only; and which, I apprehend, may be found to be the cause of many curious and singular Phenomena.

and longer when the Air is in a state favourable for Electricity. While they are asunder, and any non-electric is brought near them, if that non-electric is of a broad surface, it is with difficulty they are discharged of their Electricity; but if the point of any, especially of a metallic body, be presented, they are instantaneously deprived of their electrical virtue: but if they be in conjunction together, they retain their Electricity with so much obstinacy, that even the sharpest point of metal cannot deprive them of it. In this, and in some other respects, there appears to be such a resemblance between the Leyden Phial, or the electrical Pane of Glass, and the black Stocking in conjunction with the white, especially when the one is within the other, that I have been induced to consider them both in the same light. In both cases, the *positive* Electricity is on the one side, and the *negative* on the other; and the Stockings as well as the Phial, and the Pane of Glass are at once electrified *positively* and *negatively*. In both cases there is an accumulation of Electricity, and a retention of it, far beyond what is to be met with in a simple body, electric or non-electric. There is, however, a very remarkable difference between them in two respects. In the Phial, and in the Pane of Glass, an explosion is always obtained by carrying on a communication between the two sides by the interposition of a non-electric; but in the case of the black

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Stocking and the white, I never yet have been able to procure an explosion, nor so much as a speedy discharge by any means I could think of, while the one was within the other. I have put one hand within the innermost and with my other have clasped the outward Stocking; nay, I have thrust in my hand, and turned the Stockings inside out, and, in that condition, have dashed them against the floor: and all this without producing the least perceptible discharge. On the other hand, the phial and the pane of glass afford no opportunity of separating the *positive* from the *negative* Electricity, so as to shew them entire and distinct from each other; whereas we need only pull the Stockings asunder, and then in the white we find the *positive*, and in the black the *negative* Electricity.

*Sixthly.* When the Stockings are separated, and in the dark, upon presenting to them the point of one's finger, or any small metallic body, round at the end, they exhibit the appearance of electrical fire or light, according to the *negative* or *positive* state of the Stocking the object is presented to. With the black at the distance of two or three inches, there appears to dart from the end of one's finger a sprig or pencil, as it were, of fiery sparks, which dilates in its progress, and strikes against the surface of the Stocking, at the same time a crackling or snapping noise is heard. When the first discharge is made, upon presenting the  
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finger to a fresh part of the Stocking, the same Phenomenon is repeated till you have traversed the whole length of the Stocking, which, when the finger moves slowly, usually yields eight or ten distinct discharges, before it is divested of its Electricity. With regard to the white Stocking, the same appearances hold, but with this difference, that, instead of sparks of fire issuing from the finger, a little globule of white or bluish light is seen at the point of it; and, when the Electricity is strong, that little body of light seems to break in an explosion between the stocking and the finger; and rather a hissing than a crackling noise is heard.

*Seventhly.* The electrical Phial may be charged by the stockings either *positively* or *negatively*, according as the wire from the neck of the Phial is presented to the white or the black; and in the one, or the other case, the hissing or the crackling noise is louder than when any common wire or non-electric body is presented: but if the Electricity of the white Stockings be thrown into the Phial, and upon that the Electricity of the black, or *vice versa*; in that case, the Phial will not be electrified at all.

The charging of the Phial was among the first of my Experiments with electrified stockings. By some trials I made in the month of December last, I found it would succeed. One frosty evening in that month, having thrown into a small Phial, filled with quicksilver, the Electricity of one black Stocking, I received from

from the Explosion a smart blow upon my finger. With the Electricity of two stockings, the blow reached both my Elbows; and by the means of four, I kindled spirits of Wine in a Tea-spoon, which I held in my hand, and, at the same time, I felt the blow from my elbows to my breast. It may not, however, be improper to observe, that the Electricity, in this case, was excited by means of the Leg.

From what has been said in the preceding Pages it is evident, that all the remarkable appearances of Electricity, hitherto discovered, may be exhibited by a simple Apparatus of black and white Silk. But this is not all, in the course of Experiments above-mentioned, something curious has occurred to my observation, of which I do not find that any notice has been taken by others. — What I mean is a strong Cohesion produced by Electricity. But as this Paper is already extended to a great length, I shall reserve the account of electrical Cohesion for another, which I shall soon have the honour of presenting to the Society.

### P A P E R III.

#### *Of Electrical Cohesion.*

Read June 21st. 1759.

“**A**CCORDING to what I promised in the conclusion of my last Paper, I come in this to give the Society an

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account of Cohesion produced by Electricity. I had not made any great progress, in the series of Experiments and Observations I have already had the honour to communicate, before I perceived that the black and white Stockings, when electrified, and allowed to come together, not only joined extremely close, but actually stuck to each other; insomuch that unless when weak in Electricity, or improperly applied, I could make the White bear the weight of the Black, or the black that of the white, and that for a considerable time. But as the Weather, for some Months in Winter, was so seldom favourable for electrical Experiments, that I had scarcely opportunities sufficient to satisfy myself with regard to other points, I did not enter upon an examination of this Phenomenon experimentally, till about the latter end of March. By that time I had got ready the scale of a balance properly fitted with a hook to catch hold of the Stocking, a set of Troy-weights I could depend upon, and an exact pair of Scales, to take the precise weight of the Stockings as occasion should require.

By experience I found that the same pair of Stockings did not always do equally well, even independently of the Weather; and, that by being too frequently electrified at a time, their virtue appeared to diminish. I therefore judged it proper to be provided with changes of pairs; and that there might be the greater conformity  
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between the Experiments, I chose them as exactly as possible of the same size and substance. The sort I fixed upon is what is called half Gauze, the weight of the white Stocking, at an average, 18 penny-weights and 10 grains; but when dyed black 1 ounce and 1 penny-weight, the weight being increased by the dying of that Colour, above 5 penny-weights in the pair. When the white and the black stockings were warmed at the Fire, so as to be prepared for Electricity, they usually lost about a twentieth part of their weight; so that in the course of my Experiments, I rate the white at 17 penny-weights and an half, and the black at 1 ounce. The Scale, with the silk lines that belonged to it, and the hook was adjusted precisely to the weight of 1 ounce; and as I commonly measured the strength of Cohesion by fixing the hook to the black Stocking, and taking hold of the white, I had but to make an allowance of two ounces more than the weights put into the Scale, so as to take the precise weight the Stockings could raise by the Power of Cohesion.

I measured this Power two different ways; the first, while the one Stocking was still within the other; secondly, when separated, and the one afterwards applied externally to the other. In the first of these cases, it may be thought that an allowance should be made for the friction in pulling the Stockings asunder; but that appeared to me to be very inconsiderable, for

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when those of the same colour were put one within the other and inverted, they dropped afunder of themselves; or if there was any entanglement about the heel, a little shaking disengaged and separated them: However, if it should be thought proper, the allowance of an ounce may be made, by deducting so much from the weight respectively found.

I have but one Circumstance more to mention before I proceed to give the result of my Experiments; which is, that we must not be surpris'd when we find the force of Cohesion externally to be in no more regular proportion than that within; for when the Stockings are highly electrified, they rush with such impetuosity, that it is extremely difficult to direct their motion, and make them meet in the manner most advantageous for Cohesion.

In the Experiments I have made to measure the force of electrical Cohesion, I have always found it answerable, so far as I could judge from appearances, to the degree of Electricity at the time excited. When the Stockings have been but weakly electrified, I have found them unable to support the weight, the one of the other. When in a more powerful state of Electricity, I have known them to raise, respectively, from *one to twelve* ounces, and upwards; nay, once I found the Cohesion so strong as to move *seventeen* ounces, including the Scale and the black Stocking. For the sake of accuracy, I shall give a particular account of the result of a



few of my most remarkable Experiments, as I find them in the Notes, which I took at the time of making them.

The first I find is of the 30th of March, the Wind at north-east, the Weather clear, inclining to frost. The white Stocking within the black raised the weight of one pound one ounce six penny-weights and an half, half a penny-weight more separated them. I find no note here taken of the weight born by the Stockings applied externally to each other.

April 6th, a hazy and wet morning; but the wind at north-east. With new Stockings, the white being within the black, raised eleven ounces — without, six ounces. With another pair that had been much used in Experiments, the white within raised six ounces — without three ounces.

April 16th, a clear dry morning, the wind at north-east, Fahrenheit's Thermometer at 48. Of the new, the white Stocking within raised one pound five ounces — without, six ounces fifteen penny-weights. Of the old, the white Stocking within raised eight ounces — without five ounces fifteen penny-weights.

The force with which the black and the white Stockings cohere is not the only thing remarkable in their junction. The solution of that Cohesion, and the different degrees of tenacity according to different circumstances afford some curious Observations.

When the black and the white Stockings are

in Cohesion with each other, if another pair, more highly electrified, be separated, and presented to the former, still in conjunction, the black to the white and the white to the black, in that case the Cohesion of the first pair will be dissolved, and each Stocking of the second will carry off that of its opposite colour adhering to it. If the degree of Electricity of both pairs be equal, the Cohesion of the first pair will be weakened, but not dissolved, and all the four will cohere, forming, as it were, one mass. If the second pair be but weakly electrified, the Cohesion of the first pair with one another will be but little impaired, and that of the Stockings of the second with those of the first will be weak in proportion. And lastly, if the second pair be not at all electrified, or if, in their place, any other body not electrified be presented, there will be no effect produced on either hand.

White Silk and black, when electrified, not only cohere with each other in the manner shewn above, but in a high degree of Electricity, are found both one and the other, to adhere to bodies of broad and even, or polished surfaces, though those bodies be not electrified. This adhesion I discovered accidentally. While I was about some electrical experiments, having, without design, thrown a stocking that was highly electrified hastily out of my hand, I was surpris'd to find it, some time after, sticking against the paper hangings of my room. This

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desired me to make the following experiments.

I presented the white and the black Silk, highly electrified and in cohesion with each other, about the hangings; but no effect was produced. I then separated the black from the white, and presented them singly; in that case each of them readily adhered to the hangings, which they did when flung from a little distance, and continued there for near an hour before they dropped. Having stuck up the black and the white, in the manner above-mentioned, I came with another pair of Stockings highly electrified, and applying the white to the black, and the black to the white, I carried them off from the wall, hanging on those that had been applied to them. When the second pair were electrified, but to a moderate degree, on applying them in the manner above described, the former immediately quitted their hold of the hangings, and dropped to the ground. The same Experiments held with painted boards of the room, and likewise with the looking-glass, to the last of which both the black and the white Silk appeared to adhere more tenaciously, than to either of the former.

Having been told by one of my friends, that they had tried some of my Experiments mentioned in the preceding papers, but could not get them to succeed: I beg leave to add a few words before I conclude, by way of Caution to any, who may have a curiosity to verify my Experiments.

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However easy it may seem to be to follow the directions I have already given in electrifying the Stocking, I am sensible from my own experience, that an attention to a number of little circumstances, besides some small degree of address, is requisite, in order to make it succeed readily. This is known to have been the case with the electrical Tube and Globe: Few people, at first, knew how to manage them successfully; and yet Glass is not so much exposed to many inconveniencies, that affect Electricity, as Silk. To give but one instance of this: We know that a very small quantity of dust, or grease, or any other matter that sticks to the Tube, will injure its Electricity: Now this is what may easily be wiped off from Glass; but it may be very difficult to clear the Silk of it, as Silk is of a nature more apt to imbibe, and retain extraneous matter than Glass.—From these considerations I should not be surpris'd at any person's being disappointed, as to the success of their Experiments, in a few trials; but I should think it not fair for them to conclude from thence, that those above recited are not to be depended upon (*a*). Yet, if any Mem-

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(*a*) The circumstances necessary to be attended to, in order to procure the most considerable appearance of Electricity are as follow. 1<sup>st</sup>, That the Wind be in the north, north-east, or east, the Weather clear and frosty, or inclining to frost. 2<sup>dly</sup>, That the Stockings be of Silk; one of a good black, the other of a clear white, and both of the same size and substance. 3<sup>dly</sup>, That they be new; or kept carefully wrapt up in paper, and only used in electrical Experiments. 4<sup>thly</sup> and

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ber of the Society, who is curious in these matters, hath not been able to satisfy himself with regard to any particular Experiment, I shall think it no trouble to shew him, at any proper time, how it succeeds with me."

## A L E T T E R

From J. Mitchell, M. D. F. R. S.  
to the Rev. Dr. Birch, Secretary to  
the ROYAL SOCIETY, concerning  
the Force of *Electrical Cohesion*.

Read December 20th 1759.

S I R,

"I Happen'd to be at Mr. Symmer's on Saturday the 15th instant, when he desired me to be a witness to some electrical Experiments he was about to make with silk Stockings of a particular kind, which he had received for that purpose.

The weather was then remarkably favourable for Electricity, being clear and dry, with a sharp frost, which had continued five or six

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lastly, That they be dried before the fire, and warmed to about the degree of heat of the human body, before they be drawn upon the hand or leg. And when taken off, care should be had in separating them, so as to keep them at a distance from one's cloaths, or any thing that may lessen their virtue. The circumstances above-mentioned, might be gathered from what has been said in these papers; but I thought it not amiss to bring them together in this note.

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days. The wind was easterly, and had been in that quarter for ten days. It was about noon when we made our Experiments; the Barometer at 30, and Fahrenheit's Thermometer at 32.

The Stockings abovementioned were woven of carded and spun Silk, and were more substantial and weighty, than those with which he had made the Experiments mentioned in his third Paper. One pair was of a deep black, having been twice dyed in order to improve the colour. Another pair was of the natural colour of the Silk of a dusky white, and both new.

The pair of black weighed four ounces eight penny-weights and four grains; and the white three ounces eighteen penny-weights and fifteen grains.

We began with making a few Experiments with the thin Stockings formerly made use of, and found the result to be much the same with what is related by Mr. *Symmer* in his third Paper; that is, we found, that when the white Stocking was put within the black, or *vice versa*, and both highly electrified, taking hold of the one, while a Scale with weights was put to the other, we could raise seventeen ounces before the Stockings separated.

We then repeated one or two of these Experiments with some little variation of circumstances. We turned one of the Stockings inside out, and put that within the other: The  
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inner or rough sides of the Stockings being thus together, by which means they took faster hold of each other, we now found, that it required the weight of twenty ounces to separate them.

When the Stockings were separated, and applied externally to each other, they then raised the weight of ten ounces.

We next proceeded to try the electrical force of Cohesion with the Stockings of a more substantial make, viz. those I have above described, and there we found it to be much more considerable, as appears by the following Experiments.

1. When the white Stocking was put within the black (without either of them being turned inside out), so that the outside of the white was contiguous to the inside of the black, they lifted nine pounds, wanting a few penny-weights. Now, taking the weight of the Stocking to be one ounce, eighteen penny-weights, and fifteen grains (*viz.* the half of the weight of the pair as mentioned above), it follows, that by the force of its Cohesion with the black, it raised fifty-five times its own weight.

2. When the white was turned inside out, and put within the black, their inner or rough sides being contiguous, they lifted no less than fifteen pounds, one penny-weight and an half, before they separated: So that, in this case, the single Stocking raised ninety-two times its own weight.

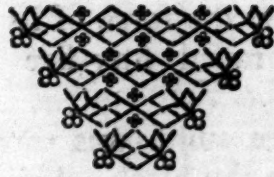
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3. When the inner Stocking was drawn out, and applied to the outside of the other, they lifted one pound and three quarters; that is, between ten and eleven times the weight of the white Stocking.

It is not my design to draw any conclusions from these Experiments, and much less to determine how far electrical Cohesion may serve, as a principle, to account for many remarkable appearances in nature. I relate the Experiments I have been witness to by way of supplement to Mr. Symmer's third Paper; and I consider the result of them, only, as a farther proof of the surprising degree to which a power in Electricity, which had not before been attended to, may be carried, in even the slightest substances, those of white and of black Silk.

JOHN MITCHELL."



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In farther Confirmation of the powerful Agency of the Electrical Fluid, if any farther Proof can be required, I will add a Letter from another very ingenious Author, tending to prove not only the Universality of the Electrical Fluid, but the same Electricity of the Human Body, and that of the Cloaths we wear :—And as a variety of passages of the former are analogous to many contained in the latter, I shall insert them in this Place.

These EXPERIMENTS are entitled,  
Singular EFFECTS of ELECTRICITY,  
By P. BRIDONE, F. R. S.

Which he introduces with Remarks on Vegetation, as follows.

“ **O**F all the reasons assigned for the wonderful Vegetation that is performed in different parts of the world, there is in fact none that contributes so much towards it, as a constant Electrical State of the Air. From a variety of Experiments it has been found, that an increase of the Electrical Matter increases the progress of all Vegetation. It probably acts there in the same manner as on the Animal Body ;—the Circulation we know is performed quicker ; and the juices are driven through the small vessels with more ease and celerity. This has often been proved from the immediate

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removal of Obstructions by Electricity; and probably the rubbing with dry and warm flannel, esteemed so efficacious in these cases, is doing nothing more than exciting a greater degree of Electricity in the part; but it has likewise been demonstrated, by the common Experiment of making water drop through a small capillary Syphon, which the moment it is electrified runs in a full stream. — I have, indeed, very little doubt, that the fertility of our Seasons depends as much on this quality in the Air, as either on its heat or moisture.

Electricity will probably soon be considered as the great vivifying Principle of Nature, by which she carries on most of her Operations. — It is a fifth Element, perfectly distinct, and of a superior nature to the other four, which only compose the corporeal parts of matter: But this subtile and active fluid is a kind of Soul that pervades and quickens every particle of it. When an equal quantity of this is diffused thro' the Air, and over the face of the Earth, every thing continues calm and quiet; but if, by any accident, one part of matter has acquired a greater quantity than another, the most dreadful consequences often ensue before the equilibrium can be restored. — Nature seems to fall into convulsions, and many of her works are destroyed. — All the great Phenomena are produced; Thunder, Lightning, Earthquakes, and Whirlwinds: For, I believe, there is little doubt, that all these often depend on this

this sole cause. And again, if we look down from the sublime of Nature to its minutia, we shall still find the same Power acting, though perhaps in less legible Characters; for as the knowledge of its operations is as yet in its infancy, they are generally misunderstood, or ascribed to some other cause. However, I have no doubt, that in process of time these will be properly investigated; when Mankind will wonder how much they have been in the dark. It will then possibly be found, that what we call sensibility of nerves, and many of those diseases that the Faculty have as yet only invented names for, are owing to the Body's being possessed of too large or too small a quantity of the subtile and active Fluid; that very Fluid perhaps, which is the vehicle of all our Feelings; and which they have so long searched for in vain in the nerves: For I have sometimes been led to think, that this Sense was nothing else than a slighter kind of electric effect to which the nerves serve as *Conductors*; and that it is by the rapid Circulation of this penetrating and animating Fire that our sensations are performed. We all know, that in damp and hazy weather, and when it seems to be blunted and absorbed by humidity; when its activity is lost, and little or none of it can be collected, we ever find our spirits more languid, and our sensibility less acute: When therefore the Air seems totally deprived of it, the whole System is unstrung, and the nerves seem to lose both

both their tension and elasticity, till the north or west wind awakens the activity of this animating power, which soon restores the tone, and enlivens all nature, which seemed to droop and languish during its absence.

It is likewise well known, that there have been instances of the human Body becoming electric without the mediation of any electric substance, and even emitting sparks of fire with a disagreeable sensation, and an extreme degree of nervous sensibility.

About seven or eight years ago, a Lady in Switzerland was affected in this manner, but I was not able to learn all the particulars of her case: however, several Swiss Gentlemen have confirmed to me the truth of the story. —

She was uncommonly susceptible of every change of weather, and had her electrical feelings strongest in a clear day, or during the passage of thunder clouds, when the Air is known to be replete with that fluid. Her disease, like all others which the Doctors can make nothing of, was decided to be a nervous one; for the real signification of these words I take to be only, that the Physician does not understand what it is.

Two Gentlemen of Geneva had a short Experience of the same sort of complaint, though still in a much superior degree. — Professor *Saussure*, and young Mr. *Jalabert*, when travelling over one of the high Alps, were caught amongst thunder clouds; and to their utter astonish-



astonishment, found their Bodies so full of electrical Fire, that spontaneous flashes darted from their Fingers with a crackling noise, and the same kind of sensation, as when strongly electrified by Art. — This was communicated by Mr. *Jalabert* to the Academy of Sciences at Paris, I think, in the Year 1763; and you will find it recorded in their Memoirs.

It seems pretty evident, I think, that these feelings were owing to the Bodies being possessed of too great a share of electric Fire. This is a very uncommon case; but I do not think it at all improbable, that many of our invalids, particularly the hypochondriac People, and those we call *Malades Imaginaires*, owe their disagreeable feelings to the opposite cause, or the Bodies being possessed of too small a quantity of this Fire, for we find that a diminution of it in the Air seldom fails to increase these feelings, and *vice versa*.

Perhaps it might be of service to these People to wear some electric substance next their Skin, to defend the Nerves and Fibres from damp, or non-electric Air. — I would propose a Waistcoat of the finest Flannel, which should be kept perfectly clean and dry; for the effluvia of the Body, in case of any violent perspiration will soon destroy the electric quality: This should be immediately covered by another of the same size of Silk, but without being sewed together. The Animal heat, and the friction that exercise must occasion betwixt these

these two substances, produce powerful Electricity; and would form a kind of electric Atmosphere around the Body, that might possibly be one of the best preservatives against the Effects of damps.

As for our Swiss Lady, I have little doubt that her complaints were owing in great part, perhaps entirely, to her dress; and that a very small alteration, almost in part of it, would effectually have cured her. A Lady who has her Head surrounded with a Wire-cap, and her Hair stuck full of metal Pins, and who at the same time stands upon dry Silk, is to all intents and purposes an electrical Conductor insulated, and prepared for collecting the Fire from the Atmosphere: And it is not at all surprising, that during thunder storms, or when the Air is extremely replete with electrical matter, she should emit sparks, and exhibit other appearances of Electricity. — I imagine a very trifling change of dress, which from the constant versatility of their modes may some day take place, would render this Lady's disease altogether epidemical amongst the Sex. Only let the soles of their Shoes be made of an electric substance, and let the Wires of their Caps, and Pins of their hair be somewhat lengthened and pointed outwards; and I think there is little doubt that they will often find themselves in an electrical state: But indeed, if they only wear silk, or even worsted Stockings, it may sometimes prove sufficient; for I have often

often insulated Electrometers as perfectly by placing them on a piece of dry Silk or Flannel, as on Glass.

How little do our Ladies imagine, when they surround their heads with Wire, the most powerful of all Conductors; and at the same time wear Stockings, Shoes and Gowns of Silk, one of the most powerful repellents; that they prepare their Bodies in the same manner, and according to the same Principles as Electricians prepare their Conductors for attracting the Fire of Lightning! If they cannot be brought to relinquish their wire Caps and their Pins, might they not fall upon some such preservative as those which of late years have been applied to Objects of much less consequence?

Suppose that every Lady should provide herself with a small chain or wire, to be hooked on at pleasure during thunder storms. This should pass from her Cap over the thickest part of her hair, which will prevent the fire from being communicated to her head, and so down to the ground.—It is plain that this will act in the same manner as the Conductors on the top of Steeples, which from the metal Spires that are commonly placed there, analogous to the pins and wires, were so liable to accidents. You may laugh at all this, but I assure you I never was more serious in my life. A very amiable Lady of my acquaintance, Mrs. Douglas of Kelso, had almost lost her Life by one of those Caps mounted on wire. She was stand-

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ing at an open Window during a thunder storm: The Lightning was attracted by the wire, and the Cap was burnt to ashes; happily her hair was in its natural state, without powder, pomatum, or pins, and prevented the fire from being conducted to her head; for as she felt no kind of shock, it is probable that it went off from the wires of the Cap to the wall, close to which she then stood. If it had found any Conductor to carry it to her Head or Body, in all probability she must have been killed.— A good strong head of hair, if it is kept perfectly clean and dry, is probably one of the best preservatives against the fire of lightning. But so soon as it is stuffed full of powder and pomatum, and bound together with pins, the repellent force is lost, and it becomes a Conductor (a). We have it ever in our power to be

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(a) Since the writing of this, the Author has made some Experiments on the Electricity of Hair, which tend still to convince him yet more of the truth of what he has advanced.

A Lady had told him, that on combing her Hair in frosty weather, in the dark, she had sometimes observed sparks of fire to issue from it. This made him think of attempting to collect the electrical fire from Hair alone, without the assistance of any electrical Apparatus. To this end, he desired a young Lady to stand on a cake of bees-wax, and to comb her Sister's Hair, who was sitting on a Chair before her. Soon after she began to comb, the young Lady on the wax was greatly astonished to find her whole Body electrified, darting out sparks of fire against every object that approached her. The Hair was extremely electrical, and affected an Electrometer at a very great distance: He charged a metal Conductor from it with great ease; and in the space of a few minutes collected as much fire immediately from the Hair, as to kindle common spirits; and by means of a small phial, gave many small shocks to all the Company. A full account of the experiment is in the Philosophical Transactions for the year 1751.

making

making Experiments in Electricity. And although this fluid is the most subtle and active of any that we know, we can command it on all occasions; and I am now so accustomed to its operations, that I seldom comb my hair, or pull off a stocking, without observing them under some form or other. How surprising is it then, that Mankind should have lived and breathed in it for so many thousand years, without almost ever supposing that it existed!"

Before I conclude my Observations on the present Subject, I cannot help Remarking the great Satisfaction and Pleasure attending the Thought of being gotten into the Track that leads to true Science. This made me think of the yet much greater Pleasure and Happiness, that must follow from an everlasting Succession of such pleasing Ideas. These Thoughts brought to my Mind a periodical Paper that I had formerly read, entitled the *Free Enquirer*, wherein the Author attempted to display the future Happiness of intellectual Beings. The Conjectures of that Writer on the same head afforded such a variety of pleasing Ideas of Knowledge and Happiness in a future State, that it prevailed with me to treat my Reader with it, expecting it would afford him the same pleasant Repast that it did to me.

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count of these Experiments was lately read before the Royal Society. They were made during the time of a very hard frost, and on a strong head of hair, where no powder or pomatum had been used for many months." See the Universal Magazine for May, 1773. p. 250.

KNOWLEDGE is the Characteristic whereby we are distinguish'd from the *brute* Creation. And although we are told by the wisest Man, that he who increaseth Knowledge increaseth Sorrow; yet we are not to infer from thence that Science is an object unworthy of our pursuit, but only that our highest intellectual Acquirements in this World are partial and unsatisfying; and that after our most assiduous Application we shall find, to our Sorrow, that although we may have learned much, yet many more things still remain, which cannot be fathom'd by the short line of human Understanding. However, it must be allow'd, that Knowledge is productive of a proportionable degree of Pleasure, and an uninterrupted succession of it would be the nearest approach to perfect Happiness.

“THERE is scarce any thing,” says the ingenious Author of the *Free Enquirer*, “more agreeable, than to consider the gradual rise and improvement of the human Species. At first they are Infants, weak and helpless, with no appearance of any rational or moral Powers; and were a perfect Stranger to the Race, and to our World, to observe them then, it would appear very unlikely to him, if not impossible, they should come to be the Creatures they afterwards are. From Babes they rise to Childhood, from Childhood to Youth, and all the while their Facul-



Faculties insensibly open, their Powers unfold in themselves, they learn Habits and Experience, until at length they are fitted for, and arrive at Manhood, where their intellectual and moral Capacities shew themselves in their full strength, and scope and opportunities are given for the exercise and improvement of them. After this, when by means of the probation and discipline of Life, their Characters are formed to Virtue; and when the moral Principle is raised to its due state of influence, and the requisite temper and preparations for a higher state of Being and Bliss are acquired; they are taken from hence; they drop their present frailties and imperfections; they exchange Earth for Heaven, and rise from the Rank of Men to that of Angels.

— It is very natural to reflect here on the Wisdom and Goodness of God, in causing our Existence to be thus progressive; in making one stage of our Being a preparation for another; and not introducing us into any larger Spheres of Action and Enjoyment, before we are in a proper manner qualified for them.

But what I have chiefly in view at present is, to take notice, that our progress will by no means end with this Life; that our next advance will not be our last and final one; but that, most probably, we shall always be in a Progress of Being, and for ever advancing. It seems quite unreasonable to suppose, that good Men will hereafter get to a point, beyond which they cannot go; or that a period can  
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ever arrive, when an entire stay will be put to their Enquiries and Improvement, and nothing further of Good, or Knowledge, or Virtue and Perfection, can be expected. That all, that we perceive, of our Existence is progressive, affords a presumption that it may be so throughout. The Nature of the Soul of Man is evidently such, that it appears capable of Improvements, to which we can set no bounds. It may have various Faculties, now latent, which in another World are to appear, and innumerable Powers, Sources and Capacities of Pleasure, which hereafter, in their proper successive periods, will be for ever springing forth, and exerting themselves: And who knows what degrees of Bliss the unfolding of one new Faculty may occasion? What additional Dignity, full scope for the exertion of one new Power may give us, and what Laws and Scenes of Nature, now inconceivable to us, one superadded Sense may discover to us? There may be also innumerable Regions and Districts of this Universe, each of them surpassing unspeakably, and through an endless progression, the other in Glory; to the view and contemplation of which we may in due succession, and as we grow more capable, be always rising; but all or any proportionable part of which it will not be possible for us ever to see, and get acquainted with. — There is, farther, an infinity of abstract knowables; and, in short, Truth, and Being; the amazing Scenes of Nature; the possible Objects of our Minds; their

their Wishes and Powers; and the divine Nature and Perfections, are boundless and inexhaustible. There appears, then, nothing to stop our progress. We have infinite room to expatiate in, and scope for eternal advances. Suppose, therefore, what is now pleaded for, to be fact; and it will be evident, that it is saying nothing, to affirm that a time must come, when there will be a greater difference between what we shall be then, and what we are now, than between the first Archangel, and the meanest Reptile; when, to take in, and survey this whole Globe, or even System, will perhaps be no more to us, than it is now to observe what passes in the same Room with us. There would appear nothing incredible in this, if Persons would but consider, that by going on to improve, let it be ever so slowly, through infinite Ages, we must make more, and higher Acquisitions, and come to greater degrees of Knowledge, Goodness, Wisdom, Power, and Perfection, than any which it is now possible for us to assign or imagine; that this Earth, nay probably this whole visible frame of Sun and Stars, compared with the immensity of the Creation, is but a point, and that nothing finite bears any proportion to what is infinite.

From thus viewing things forwards, and considering the future progress of reasonable Beings, I cannot help taking occasion to turn my Thoughts backwards, and observing that there must undoubtedly exist Beings who were  
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the first Productions of the Divine Power; that the time which has intervened since these received their Existence (though it should be allowed impossible to be properly Infinite) yet is in all probability Indefinite; that through this whole immeasurable length of duration, they have been growing and improving, and consequently must e're now be arrived at degrees of Intelligence, Dignity, and Excellence, that are above all human Conception.——For my part, I am well convinced, that even after our utmost endeavours to the contrary, we are apt to entertain much too low Ideas of the System of the Creation, and the possible, nay actual, Dignity and Grandeur of intellectual Beings. It must not, be forgot, however, that how highly soever we conceive of reasonable Creatures, and whatever degrees of Superiority and Perfection we believe they may possess; yet they are, and (after the farther Improvement of numberless Ages) must ever continue, all equally dependent upon, and inferior to the Creator; all (strictly speaking) equally nothing, compared with him, and at the same, that is an infinite, distance from original, necessary absolute Perfection.

But to return to the Contemplation of our own Natures and Hopes; upon any notion of the future state, it must be true, that we are now as incapable of forming any Idea of what we are to be, in it, as a Child in the Womb is of forming an Idea of State, Employment

ment, and Happiness, of a grown Man. But take in the Consideration that we are to be always improving, and it will appear, that, in no assignable future period of our Existence, we shall be able to conceive what we are further to be, in the periods beyond that.

Here I find it almost impossible to restrain myself.——To be eternally ascending in the Scale of Being! How high then shall we at last reach! And, though always happy to the utmost extent of our Wishes, yet not to be able to imagine, in any part of our future Being, how much more happy, great, and good, we are to be! What a Prospect is this! How vast! How astonishing!

These observations naturally give occasion to enquire, 1st, Whether it is credible, that Beings, who can thus extend their Views and Hopes, through Eternity, and are capable of such a Progress, should be designed for a low, momentary Existence here; should all perish in the first step of their Progress; and after just shewing themselves to the World, and being curst with the Idea and Wish of Immortality, sink into Oblivion and Annihilation?

In the next place, how can we sufficiently adore the Goodness of God, in bringing us into Being; in placing us in such a Rank amongst his Creatures, and setting before us such a Prospect?

Further; how unspeakable does the Dignity of human Nature appear when thus considered?

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What reason have Mankind to reverence themselves? And how proper and important Objects are they of that extraordinary Interposition and Apparatus to save them, which Christianity reveals? Every Particle of Matter in the Universe is continually acted upon by the Deity; but one human Mind, with such Capacities as have been represented, is infinitely superior in value to the whole material Universe; and the ruin of it, of infinitely greater Consequence.

Again; how dreadful a thing is Vice, which ruins such noble Beings, indisposes them for the Happiness of their Natures, and bereaves them of all their high and infinite Hopes? It is undoubted, that Virtue and Righteousness are, and must be, the only Qualifications for Bliss, under the Government of a Righteous Being. I am sure no wise Person will slight this Observation. For though the probability were supposed greatly against its being true; though the presumption were ever so small for the reality of such a State of ever growing Bliss as I have described, which Vice in any degree endangers the Loss of; it would still, demonstrably, be the extreme of Madness not to resign all for the sake of it, and not with the greatest Anxiety to avoid what may, any way, tend to diminish our Chance for it.

Finally; such Reflections as those above made, should, surely, raise us above this World, and lessen our Attachment to it. How sad is it to see the Heirs of such Hopes wallowing in  
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the Mire, and revelling with Brutes ! How unnatural for Minds which the whole World cannot buy, that can take in the Universe, and were born for Eternity, to contract their Wishes and Regards to a point, and an instant !

We are to outlive the Sun and the Moon. What an Elevation and Dignity should the View of this give to our Behaviour ? How should the unbounded Prospect loosen us from the Earth, and give Wings to our Minds ! How should we trample on the Tinsel of Life, and anxiously avoid every thing unbecoming our vast Expectations ! What can we think of those groveling Souls who forget their higher Country ; who disgrace their heavenly Original ; who can contentedly look forward to Annihilation ; whose Ambition rises no higher than the present State ; and who abandon the common and rational Hope of Mankind concerning a future Immortality ? These renounce the noble Principles and Aims of all that are worthy to be reckoned Men, and should indeed be looked upon as betrayers of their Interests, as Traitors to the Species, as Fugitives from the Rank and Station, the Dignity and Privileges of reasonable Beings ; and ought to be treated with suitable Scorn and Contempt.

To conclude : Human Life considered in itself, and compared with our whole duration, and unlimited Capacities and Hopes, is indeed so little and low a Thing, that it scarcely deserves the Name of Existence ; and it is abso-

lately of no moment what befalls us in it, any farther than it affects our Tempers and moral Characters, and helps or hinders our Meekness for what comes after it. Its Riches, Pleasure, Power, and all that is commonly courted and pursued by unthinking Mortals, are unworthy a single Wish, or Thought of a well informed Mind, or of one who believes, or but suspects it possible, that he is to live for ever.

And here I cannot but remark with concern, that notwithstanding we appear thus capable of such a blissful succession of future transcendent Knowledge, yet so long as we remain in this Life, we are too apt to be wedded, as it were, to *sensual Pleasures*, and to have but little relish for *intellectual Enjoyments*. But surely if we reflect a moment on the vast disparity which is between them, how unsatisfactory the very fruition of the former is, and how short their duration; whilst the Joys of the latter are refined and permanent, and constantly advancing in a gradual Progression towards Perfection, we cannot, without Reproach to our Reason, make so absurd a Choice as to give the preference to those which are least valuable.

## CONCLUSION.

I shall conclude this Supplement with observing, that as there is but one true Religion, so neither is there more than one true Philosophy. Truth being always uniform and consistent with itself.

“It is impossible,” as the Rev. and learned Mr. Jones in his First Principles on Natural Philosophy religiously observes, “that true Religion and true Philosophy should be at variance, because He, who created all those Works, which are the proper Objects of natural Philosophy, was also the Author of Divine Revelation; and God is not divided against Himself.”

True Philosophy, according to former Professors, is founded on an universal Vacuum and a mutual Attraction of the parts of Matter in order to account for their mutual tendency towards each other; but since the commencement of modern electrical Experiments, an elastic subtle Medium or *Æther* is discover'd to exist; from the effects of which, electrical Philosophers can produce undeniable Evidence to prove, that instead of an absolute Vacuum and a mutual Attraction to cause such tendency, an absolute Plenum exists and an impelling force: Since therefore one of them only can  
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be true, they humbly propose, that in order to decide the grand point, a strict scrutiny may be made into the merits of both, which being once done, Philosophers will no longer halt between two such different and contradictory Opinions; but we shall then go hand in hand, and proceed in our physical Researches with Perspicuity and Pleasure. — As such a strict examination can injure neither Party, 'tis presumed no impartial Enquirers can reasonably reject the Proposal; and the motive which can prevent such a strict examination must favour strongly of invincible prejudice.

Unless such a decisive method be pursued, and electrical Philosophy be thoroughly examined, as proposed, the current Philosophy must necessarily remain where Sir *Isaac Newton* left it, which, as he informs us in the Preface to his *Principia*, was then in an intricate state, and that Philosophers attempted the search of Nature in vain (a); intimating also at the same time, that the receiv'd Philosophy was *not a true one*. And they seem not yet much more inclined to attempt the search of Nature upon any other plan than that which they have so long and so unsuccessfully pursued; and not any besides a few electrical Philosophers attempt to explain it, at the present, on any other

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(a) Electrical Philosophers are certain that it was out of the power of Philosophers to attempt the search of Nature with Success, before a more elastic subtile Medium was discovered to them than that of the common Air.

Principle, notwithstanding the length of time the electrical subtle Medium has been discover'd, and our intimate familiarity with it by means of the numberless Experiments which have been made upon it; and yet we seem almost as much unacquainted with it as ever; for go into what Company we will, if Electricity happens to be the Topic of Conversation, nothing is more common than to hear Men expressing the greatest Admiration concerning it, asking us, What can it be! Whence does it proceed, and how do you account for that surprising Power and Force which we behold in most of the Experiments? And what is very remarkable, not only common People thus interrogate, but the learned and sagacious.

Electrical Philosophers solve those formidable Difficulties by Principles previously proved; i. e. that the electrical Fluid is an universal Fire in the form of an extremely fine and pure elastic Air. That all Nature is necessarily replete with it, insomuch that an absolute Plenum of it becomes the natural Consequence. That by means of its force and action, all the abstruse Phenomena exhibited in the Experiments are solv'd. They moreover produce undeniable Evidence to prove that this elastic Fire acts on all other Bodies with an impelling force.

But in order to render this method of Reasoning yet more satisfactory, I must subjoin the six fundamental Articles contained in my Essays, p. 22, that the Readers of the present Work may

may have them ready at hand to consult in their researches upon all occasions.

*First.* That in the beginning, the ALL-WISE and OMNIPOTENT CREATOR of all Things formed an universal æthereal Fluid or primary Air, endued with the utmost purity, subtilty, and rarity; and in fine, a perfectly subtle elastic Fluid.

*Secondly.* That the whole Universe is replete with it; for otherwise a Fluid so perfectly subtle and elastic would be perpetually expanding, till all parts were equally full; and then neither the whole, nor its parts, could remain endued with that perfect elasticity, which was at first supposed, and at present appears to be.

*Thirdly.* That this Æther or pure Air is universal, not only in all open spaces, but in the minutest vacuities of the most compact Bodies, by reason of its being composed of almost infinitely finer Particles than those of gross Matter, which renders it capable of permeating the smallest Pores and Interstices of the hardest and closest Substances.

*Fourthly.* Since the Earth is endued with a property of transpiration or of breathing forth the most volatile parts of it to a considerable height from its surface; those Effluvia become blended, incorporated, and most intimately mixed with Particles of the universal pure Æther or primary Air, and by that means constitute a secondary Air (*a*), or aerial Fluid, and the only one that could (till now) be proved to exist.

(*a*) Atmosphere

Fifthly.



*Fifthly.* That from the elasticity of its Particles ariseth an Intumescence, a swelling or expanding Property and constant endeavour of extending their Limits to greater Dimensions: Hence they, and consequently all masses composed of such elastic Particles mutually repel.

*Sixthly and Lastly.* That this universal Air, although invisible, is nevertheless true and real Fire in the strictest sense of the word, and endued with the utmost Force.

These Articles were at first proposed as a Theory only, and having for seven or eight years past been strictly and repeatedly examined, without the least degree of prejudice by the Author, who cannot find any reason to alter his Sentiments; 'tis therefore presumed they are justly founded and may be safely carried into Practice.

What I mean by Theory and Practice is, that having been versed in a Theory for seven years, it must then be high time to attempt the Praxis: that is, after having pursued the analytical method a sufficient length of time, we may fairly proceed to the synthetical; viz. we may then reason *a priori*.

B. Our greatest Naturalists seem unanimously to explode *that* method of reasoning in their physical researches. The grand Hypothesis of *Des Cartes* being founded entirely on *a priori*, might possibly be one principal cause for rejecting the whole: But can you assign any other reason?

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A. Before the Discoveries that have been made by means of the electrical Apparatus, we had no other safe way of advancing than by reasoning *a posteriori*; there was then no other method to investigate the Cause: Whereas the means which are afforded us from Electricity having discover'd it, we may now safely proceed with precision and certainty in the other way, namely, from the Cause to the Effect.

Your Observation on *Des Cartes* in particular seems indeed to be just; as his System was very exceptionable on that account, it being merely arbitrary, and without any proper foundation for its support.

B. What have the electrical Philosophers that is remarkably substantial and unexceptionable whereon to found *their* method of reasoning *a priori*?

A. That which no Age before was ever in possession of, viz. the first Mover among secondary Causes is now realized and become clearly known to us as a permanent Principle under the form of pure Fire.

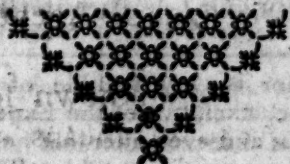
N. B. I have been the more explicit on this subject, in order to shew that there was no other than that *backward* way of proceeding in our physical researches with success, before Fire, that first mechanical Agent was discover'd.

A Glimpse of this unknown somewhat in Bodies was discover'd by means of the pneumatic Engine, and afterwards clearly confirm'd  
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and verified by the electrical Engine, and is the grand Agent which has so amaz'd Mankind, and which is found capable of solving all those otherwise inexplicable Difficulties.

Every Spectator of the Experiments plainly discover it to be true Fire; but the electrical Philosophers by means of an indefatigable and strict Examination of it for a series of years past, have at length found it to be an universal Fire in the strictest sense, not only in the pores of all gross Bodies, but consequently in all free and open spaces.

In a word, if the current Philosophers can support their doctrine of an universal Vacuum and an attracting Force in a more rational and satisfactory manner, electrical Philosophers will not only publicly acknowledge their mistake, but will think themselves highly indebted for the means of their conviction. But on the other hand, if the doctrine of an electrical Plenum cannot be refuted and fairly set aside, they appeal to all the judicious and impartial Enquirers after Truth, whether that be not a strong presumption in their favour, that their Scheme is well founded.





## POSTSCRIPT.

A. \*\*\* YOU may probably recollect that  
\* Y \* I never made any Reply to the  
\* \* \* Animadversions of the Monthly  
Reviewers on my printed Letter  
to them: My Reason for it was, that I never  
designed to have troubled myself, nor the Pub-  
lic with any more of their impertinent Cavils;  
but their Animadversions on my Philosophical  
Essays were of too insolent and flagitious a na-  
ture to be passed by unnoticed.

B. I cannot say I remember it, and there-  
fore please to proceed.

A. At page 26th of that Letter, I inform'd  
those Writers, that as I had then gone through  
their Animadversions in the manner I proposed  
at the beginning of it, I should take leave of  
them at that time, and unless they would con-  
sent to carry on the same kind of Correspond-  
ence by the channel of their monthly Paper, I  
should take a *final* leave, since it must be ob-  
vious to every one how impracticable a thing  
it was to write and publish a Pamphlet or a  
Letter every time they might think proper to  
raise an objection (*a*). But if they should re-

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(*a*) Every Author is very sensible of the trouble and  
difficulty it must be, exclusive of the Expence of a Perform-  
ance from the Press; and even after that he may justly despair  
of any small thing becoming very public: Those Writers being  
sensible of these things, and as I had inform'd them that I

ply

ply as formerly, that it was not consistent with the plan they had formed, or for want of room, &c. possibly it might be thought an evasion merely to shift off the force of the Argument; and therefore, if they had that sincere regard for Science, which they frequently expressed, they could have no just reason to reject the Proposal of carrying on such a Correspondence in the manner above mentioned.

By thus continuing an amicable communication of Sentiments on the subject of Electricity, something acceptable might be reasonably expected. We may then, if necessary, resume the same things. For although I am entirely convinced as to the repulsive scheme, yet the word Attraction could not, as I then thought, be wholly disused, particularly, when I consider'd the accumulation on the glass Tube or Globe, or in the electrical Phial, as also, how light bodies are moved with such rapidity to the body electrified, without supposing some kind of Attraction (c). If those, and the like

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should, for such-like Reasons, take a final leave of them, they might well suppose they could say whatever they pleased with impunity. These are such important Reasons that will ever prevent them from carrying on any controversy in their Review, and they are accordingly found as if proceeding on such mean Principles; and at the same time affirming for Truth, the most notorious Falshoods, as will evidently appear, when I come to their Animadversions on my Philosophical Essays.

(c) Here it plainly appears, that my Observations at that time had not furnished me with Data sufficient to enable me to account for that force, which is now plainly deducible from the doctrine of falling bodies, namely, *an exterior and universal IMPELLING Force,*

Pro-

Problems can be satisfactorily solv'd, we may hope in time, by means of such a Correspondence to arrive at so much perfection, as to attempt a true Theory, or regular System of that mysterious Science, and to see Electricity established on as firm a foundation as any other Science can claim.

*Animadversions of the Monthly REVIEWERS on that printed Letter: See the Appendix to their 26th Vol. p. 502.*

*Review.* "We little thought," say those *Reviewers*, "to have heard from Mr. Lovett again on this subject, after what passed between us in a former Review; much less that he should complain of our Severity, when he was himself, in so great a degree, the Aggressor."

*A.* What a barefac'd Falshood do they begin with when they charge me with being the Aggressor? and the reason that they give for it is as uncommon, viz. "that there are *Men* as well as *Arguments* that are unanswerable;" and it appears plainly to them, that I deserve a place among the former.

*B.* There are but few who will suppose that you were the Aggressor, unless they had shewn wherein: What did you say in your Letter that they could construe so as to make you the Aggressor?

*A.*



A. I can think of nothing, except "*shooting the Truth*" was the great Crime. The Ears of some are indeed much too tender to hear the Voice of Truth when it is pointed towards them.

*Review.* "Bad Casuist as he is, he is a bold Combatant (a); for though reduc'd to his stumps he is determin'd not to give out. — It is very justly remark'd, say they, by a judicious french Writer — "*Tous ceux qui sont capable de faire des objections, ne sont pas toujours en etat de comprendre tous les principes, dont depend la resolution de leur objections.*" — This seems to be the Case with Mr. Lovett — Indeed he frankly confesses, that our distinctions are too refin'd for the Comprehension of *Electricians*, and stiles such reasoning, in the usual cant of ignorance and incapacity, the cobwebs of Metaphysics. It does not, however, become a *mere Experiment-monger* to talk so disrespectfully of any Science (b); yet this our doughty opponent is

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(a) Methinks I should be glad to be informed what affinity a *Casuist*, i. e. one skilled in resolving Cases of Conscience, bears to a *Combatant* in any respect more than that they both begin with the same Letter.

(b) This is such a gross and ungenerous misrepresentation, that to set it in a true light and at the same time to render it intelligible, it seems necessary to relate the whole affair to you.

In the above mentioned Letter, p. 6. Section 9. these Writers being found reasoning most inconsistently concerning *electric Matter* and *electric Force*, they are reprehended in the following manner by way of note on that 9th. Section. —

very

very earnest with us to continue the controversy in our Review.

*Answer.* These Writers seem'd not aware how greatly they humour'd my vanity when they stiled me an *Experiment-monger*; a mere *Experiment-monger*; which they intended as a term of reproach; whereas, it was at the same time ranking me with three of the greatest Geniuses that perhaps ever lived. The renowned Lord *Verulam*, the Hon. and indefatigable Mr. *Boyle*, and the great Sir *Isaac Newton*, who according to the Reviewers way of reasoning and judging were some of the greatest and merest *Experiment-mongers* that ever existed.

*Review.* "But, supposing it consistent with our plan, as it is not; to what purpose should we dispute? If Mr. *Lovett* cannot comprehend us, we never can hope to convince him; and

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"That Water is a Conductor of the *electric Force*, but not of the *electric Matter*; that by every Conductor of Electricity in these Experiments, a motion only is propagated, but no real Fire conveyed, though sparks of Fire can be discharged from any point of that Conductor; these are distinctions too refined for the Comprehension of Electricians. You cannot even suppose that a mind seriously inquisitive after Truth, can be satisfied with such Cobwebs of Metaphysics. Surely, it is more Philosophical, as well as more easy and natural, when we see Fire copiously streaming from the extremities of electrified Wires ranged near together, to trust our Senses, and to admit this as ocular Demonstration of the extreme subtilty of electric Fire and of its Power to pass through densest Bodies: To talk of *electric Force*, abstractedly from the *electric Matter* is absolutely unintelligible."

as to his strong desire of entering into a nearer and closer engagement, that the Matter in debate may be brought to a fair Issue, and the Public no longer to remain in doubt which of us is in the right, we are willing to rest our Cause with the judicious Reader on the merits of what has been already said. Indeed we conceive, that those who have paid any attention to this little debate remain in no doubt about the matter: At least, we shall think so till it is intimated to us from some other quarter: In which case, when called upon by a Person capable of comprehending us and receiving satisfaction on the subject in question, we shall be ready to give it in as ample a manner as is consistent with our Work, or can be reasonably required by our Readers."

"Our Antagonist will doubtless call this in his usual stile, a jesuitical way of shifting off the Argument; intolerable arrogance; &c. we must take the liberty to tell him, however, it is not the Argument, but *the Writer we should be pleas'd to get rid of (a)*: If we must engage in a Controversy, we are indeed so far ambitious, as to wish it may be with a Writer capable of understanding, and replying to an Argument."

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(a) Had there been any Truth in that Assertion why did they seven Years after, *unprovok'd*, attack me again? — The Truth appears plainly to be this, though they seem asham'd to confess it, that they were in reality weary of the Argument, and, conscious that they were *unequal* to it, would fain shift it off to the Writer.



*Answer.* May not this be properly filed shuffling and jesuitical evasion, and such as I observ'd candid Writers would be ashamed of.

Five Years after, in the Year 1766, I published my Philosophical Essays, which Performance was taken notice of the same year, by the candid Authors of the Critical Review, who gave it so great a Character, that my cavilling *Hypercritics* had not the face to vent their spleen on it till full two years after; when they might very probably think the commendatory Character given of it by the former was forgotten. I shall therefore next inform you, that after having view'd and review'd the Contents of my Philosophical Essays, i. e. having often perused them with the greatest Care and Circumspection which my slender Capacity would admit of, and conscious that I had advanced nothing but what appeared to be strictly agreeable to Truth; yet, lest I should have been too much prejudiced in favour of my own Sentiments, which was very probable as well as natural, I made it my Business to consult not only my Friends with whom I conversed, but wrote to divers others to desire they would favour me with what appeared to them to be not well founded, and would therefore be the most liable to objection: My Intention in this was, that I might endeavour to obviate such Objections for the future; by, First, stating them in their full force, and then replying to them — These Thoughts naturally directed me to my old

old Antagonists, the *celebrated* Authors of the Monthly Review, where I had no doubt of being plentifully stock'd without any more trouble, but found myself greatly mistaken; for instead of rational Objections, and such as might be satisfactorily replied to, they were found insulting their poor Culprit in the most scandalous manner; and their Animadversions such as were quite incapable of any regular Answer, by being so stuffed with bombast, immoderate scoffing and rancour, pointed with the keenest sarcasms and scurrility on the one hand, and as ridiculously ludicrous on the other.

In short, nothing was omitted which they thought capable of rendering me contemptible; and they seem'd at the same time so vain as to think their Readers would be highly pleased with such low Witticisms and Froth (a). But although their Animadversions were unworthy and even incapable of a regular Answer, yet that you may be able to form a judgement

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(a) I had a slight view of their Animadversions soon after they were publish'd, where I found nothing but what I expected, viz. such rant as above mentioned: As I had then no intention of publishing a Supplement to my Essays, I had therefore no design of troubling myself with them any more; but when I began that, I was inclined to peruse their Remarks again, and with some attention; but especially when I found them to contain no less than ten Pages and an half, it was no wonder if they excited my curiosity so far as to examine how it was possible to spin them out to such a *respectful* extent, and what could induce such eminent Writers to bestow so much time and pains upon the trifling Labours of a Person whom they so frequently stile a most feeble Antagonist.

of them and their manner of writing, I shall give you another curious and elaborate specimen of both, which if I mistake not, you will think an original.

Those Reviewers in their Animadversions accuse me of producing or coining the Term Transpeciation. — “ While we thought”, say they, “ that we were exercising forbearance towards Mr. Lovett; behold! at page 391, [rather at page 393] our own critical sagacity at fault (a)! at the sight of the word *transpeciation* which there occurs, we own we were sufficiently disconcerted. We called forth all our philological Powers, and even summoned a Board of Criticism on the occasion, which broke up *re infectâ* after consulting every lexicaphanic Book in *Becket's* Shop, from *Hedericus* and *Johnson*, even down to the *Scoundrels' Dictionary*. ” Most Wonderful! “ We are candid enough to own, that though we at last master'd it, it was not till our Index-maker, who was in waiting upon this occasion, instinctively, as it were, spied it in the Glossary or Explanation of the most difficult Words, which Mr. Lovett, we suspect, from an old grudge, and with a view of distressing us Critics, had artfully concealed behind his Index, — [shrewdly guessed indeed!] “ we forgive him, however, and even congratulate him on the prodigious advances he has made in Literature (a) Wonderful indeed, that that should ever be at a fault!

ture



It is true, since the publication of the second part  
 of his *subtile Medium* proved: At that time  
 he durst not use the term Electrician with-

“out referring us in a note to the Authority  
 of Dr. Franklin; we find him now setting  
 up for himself, and *producing*, if not *coining*  
 a word that has puzzled a whole College of  
 Reviewers. We are prompted however,  
 perhaps, by a little spice of envy,” [shrewd-  
 ly guessed again] “to declare our opinion, that  
 this word has too ill-favour’d an appearance,  
 and is too strangely turn’d, ever to be ad-  
 mitted, without a struggle, into the English  
 Language.”

Query. Can this harangue come from Phi-  
 losophers? Can such stuff be the Language  
 of Critics? Have they not arrogantly usurped  
 the Title, and *set themselves up* as Judges of the  
 Labours of the Learned, and Censors in the  
 Republic of Letters, before they were properly  
 qualified for it? Can learned and sagacious  
 Men, such as Critics are expected to be, be  
 ignorant of the meaning of such a term as  
 Transpeciation? a term so expressive, and  
 which carries its meaning along with its sound,  
 as all terms ought to do, and particularly  
 technical ones? Could it be expected that a  
 whole Body of Critics, or indeed any learned  
 Men (not to say Body of Men) should be so  
 distressed as to summons their whole *College*  
 to the *Council Board*, about the meaning of a  
 common word; at least I had no reason to think  
 but

but it was as common and proper as most other terms, particularly as I found it in a Dictionary which has long had the approbation of the Learned (a).

Tis plain however from their own account, that they were at no small pains about finding out the meaning of that word, and tell us they had not mastered it at last, had it not been for their *Index-maker*, who, as they inform us was in waiting on that *grand* occasion. This however is thought abundantly sufficient to shew what trifling Writers they are, as well as implacable; implacable I say, since it was seven Years after they had heard from me, which was in my printed Letter to them, published in the Year 1761. — As I did not design to have any thing more to say to them, I never so much as once mentioned them in my Essays.

Is it not strange, that Critics who avow themselves to be Professors of Science, and Adepts in Languages, should be so miserably at a loss for the meaning of so significant and intelligible a term! A word for which a Boy in the lowest Class in a Grammar-school wou'd expose his posteriors to the ignominious pu-

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(a) *Bailey's English Dictionary* Edit. 3d. — I mentioned this affair to one, who shewed me the same word in an English Dictionary of *Cole's*, and doubtless it may be found in many others. Why a word, which is so expressive of its meaning as that is, should give offence, the Author would be glad to be informed; but, supposing it had not been so, has not every Writer the Liberty of choosing his own Terms, provided he, like the Author, explains them.

nishment of a whipping if he were ignorant of it; if he were not capable of informing them that Transpeciation was a compound term, consisting of the preposition *Trans*, and the noun *Species*; for the Truth of the former, let them consult their Accidence, and for the Sense of the latter, I may refer them to every latin Dictionary whatsoever. Let them blush then, if they know how, at being thus distress'd by a word which has puzzled their whole College, as they stile themselves, and let me subjoin their merited addition, of B——hds; for who but such, would not have understood at first sight, a Term so easy and expressive as *Transpeciation*?

B. Those Reviewers will surely be greatly irritated at your treating them with so little Ceremony.

A. What right they can claim to any favour from me, let the sensible and candid Reader judge, when he finds how rudely they have behaved towards me, though unprovok'd.—— As a specimen of their scurrilous treatment, let him observe the following extract.——

“ Mr. *Lovett* indeed does not seem to know  
 ‘ where the Difficulties attending the subject  
 ‘ really lie, though they are certainly obvious  
 ‘ and numerous enough in all conscience. We  
 ‘ recommend it to him therefore to give Dr.  
 ‘ *Franklin*’s Letters a careful perusal, and when  
 ‘ he has master’d them, to read Dr. *Priestly*’s  
 ‘ familiar Introduction to the Study of Elec-  
 ‘ tricity,



tricity, just published. It may seem hard and unprecedented to turn a founder of Systems down to the lower forms in the School of Electricity; but when Mr. Lovett understands either of these Performances, he will own the justice of this degradation." See Review, page 377.

This, 'tis presum'd, is sufficient to make it almost a doubt whether they are entitled to so much as common Civility, were not that a debt which we owe to all Men, even to the most abusive and deprav'd.

Those Reviewers represent me as extravagantly vain, particularly, in claiming Discoveries made in Electricity; and this accusation runs through no small part of their Animadversions.

At page 374. "Those (say they) who have read his Essays on philosophical subjects, or our accounts of them, may possibly recollect that the principal purport of them is to prove that the *Spiritus subtilissimus*, which Sir Isaac Newton supposes to be a principal Agent in many of the capital Phenomena of the Universe, is now realiz'd, and is no more than the electrical Fluid. — This Doctrine Mr. Lovett would have us look upon as a Discovery of his own, though he cannot be ignorant that there are numerous fellow Claimants."

*Answer.* The former part of this is true; but that I claim the honour of being the first Disco-

Discoverer of it is absolutely false. — As for the subtle Medium of Sir *Isaac Newton*, or the elementary Fire of the Antients, since in their time neither of them could be proved by Experiment, or that any such thing existed, all therefore that they affirmed of it could be no more than hypothesis or meer conjecture, it being only what they concluded from some of its remote effects. As therefore Electricity has discover'd, not only that such a subtle Medium exists as they had foretold, but also that it is found to be possessed of all the surprising Properties that had been ascribed to it, and that so plainly as to be realiz'd to the Senses, was it not natural for me to think, since this is so obvious, that all who were conversant with electrical Experiments should be convinced of the similarity or rather sameness of them as well as myself? I may safely appeal to all candid Enquirers, whether it was at all probable that I should suppose myself the only one who could discover so clear a Truth. — All who have read my accounts of it may find that these Writers have either not perused them with due attention, or else have designedly misrepresented them; since I have been so far from endeavouring to persuade the World that I was the only one who had made the first Discovery, that on the contrary I totally disclaimed every pretence of that kind, and think myself happy that Dr. *Hoadly* and Mr. *Wilson* coincided with me in the same Sentiments.

At page 375, they say, "Mr. *Lowatt* not only supposes that the Air extricated from Water by the action of the Air-pump is real *Æther*, but even that the bubbles which arise from the surface of a piece of brass immersed in it, are particles of *Æther* coming out from the substance of the metal. The pure electrical Air (says he) contain'd in it [the brass] soon begins to shew itself, and if the operation (of exhaustion) continues, almost the whole surface of the brass will be cover'd with little pearly bubbles which rise out of it, consequently the brass is pervious by this pure Air, i. e. the *Æther*."

*Answer.* Is it not natural to conclude so, for the same reasons there given, viz. that though the brass is pervious by this pure Air or *Æther*, it is far from being so by the common Air! so far from it, that even the barrels of the common condensing Engines are generally made of brass to confine the Air, although it be sometimes extremely condensed within side of it. — 'Tis the same in the chamber of an Air-gun, which is also made of brass, and is no more than a different condensing Engine.

If in the foregoing Experiment it had been common Air, and yet found so easy an escape out of the piece of brass in the water, when only the spring of the common Atmosphere was taken off, how much easier would it pervade the brass barrel of the condenser, or of the Air-gun, when the elasticity was then, perhaps,



ten times, or much more increased?

Notwithstanding, that so long ago as I wrote my second part of THE SUBTILE MEDIUM PROVED, in vindication of the first part, which was published in the Year 1756, at which time I was very assiduous in my endeavours to proclaim to the World, that I was *not* the only Person who was of the opinion, that the electrical Fluid and Sir Isaac Newton's Æther were identically the same subtile Fluid, yet these Reviewers had the front eleven or twelve Years after, viz. in the Year 1768, to charge me with claiming the Discovery as my own (a). To prove that this is a *false charge*, observe the following Transcript from the second part of my subtile Medium proved, entitled, Sir Isaac Newton's Æther realiz'd, p. 34.

"That the electrical Fluid is the very Æther, 'tis presum'd is what is now questioned by few Philosophers; although, when I wrote that Pamphlet, it did not seem to be generally allow'd; and to say the truth, I was for that reason under some Apprehension of being publicly chastised (if thought worthy of notice) for affirming it so peremptorily; because I was so audacious as to be the first who had ventured to speak his mind on that head so freely, at least, that I ever knew of, although several had *binted* the same thing before, particularly, the forementioned ingenious Mr. Wilson, in a former Treatise on the

(a) Monthly Review, 1768, page 374.

but electrical Fluids, who shew'd it so plainly to be his real Opinion, and his Arguments seem'd so convincing, that I could not help admiring his Opinion was not more generally receiv'd, notwithstanding the great modesty with which he deliver'd his Sentiments. Others still more cautious, only affirming the Æther to be the Cause of the electrical Phenomenon : For these and such like reasons, I was determin'd, at all events, to venture to speak my mind without any reserve, especially, as I was sure I could confirm my Arguments by the most convincing Experiments."

But contrary to my expectation, no one, that I ever heard of, condemn'd me for it. And to my still greater satisfaction, about the same time my Pamphlet was published, came out those Observations of Dr. Hoadly, in conjunction with the above mentioned Mr. Wilson, wherein they had express'd their Sentiments more fully than I had ever seen in any Author before, affirming it to be unphilosophical to suppose, that the Æther of Sir Isaac Newton, and the electrical Fluid were two distinct Fluids : 'Tis true they soften'd the expression, by saying, it was much more philosophical to suppose them one and the same Fluid, than to suppose them two.

The manner in which they express themselves is as follows :  
Thus have we gone through the most interesting

of interesting of the electrical Experiments, and  
 from the various appearances they afford, it  
 appears, that the electrical Fluid is as univer-  
 sal and powerful an Agent, at, or near the  
 surface of the Earth, as that Fluid, which  
 Sir Isaac Newton, in his Optics, calls *Æther*;  
 that it is as subtile and elastic in its nature  
 as *Æther* is; and as *Æther* does, that it per-  
 vades the pores of all Bodies whatever that  
 we are conversant with; is dispersed through  
 whatever Vacuum it is in our power to pro-  
 duce by art; and from the natural Phenomena  
 of Thunder, Lightning, &c. seems to be  
 extended to very great distances in the Air."

"We shall make no scruple therefore now  
 to affirm, that these two Fluids are one and  
 the same Fluid; and it is much more philo-  
 sophical to do so, than to suppose two such  
 Fluids, each of them equally capable of pro-  
 ducing those effects, and equally present every  
 where, which would be multiplying causes,  
 where there is no manner of occasion (a)."

See Dr. Hoadly's and Mr. Wilton's Observations  
 on a series of electrical Experiments, p. 68; or  
 my Essays, part II. page 182.

(a) The partiality of these Reviewers is remarkably no-  
 torious. Dr. Hoadly's and Mr. Wilton's series of electrical  
 Experiments, and my Pamphlet, entitled the subtile Medium  
 prov'd, were both of them publish'd in the Year 1756; mine  
 they condemn'd, for endeavouring to prove, that the electri-  
 cal Fluid was the identical *Æther* of Sir Isaac Newton: Dr.  
 Hoadly's and Mr. Wilton's series, which endeavour'd to  
 prove the same thing, was applauded by them, who declar'd  
 it to be their Opinion, that the Dr. and Mr. Wilton had  
 render'd it very probable.

B.



*B.* You have frequently hinted that the Animadversions of those Writers were of such a nature as render'd them incapable of a regular Answer; I wish therefore you would give me a Specimen of the method they make use of.

*A.* There is no arguing with Men, who are determined to turn every thing into banter and ridicule, which is their constant method, and particularly, when they come to an Argument that is likely to pinch them. Where they happen to be capable of such an Answer, there are so many insolent and ignorant Cavils, as renders them unworthy of it.

*B.* Your Assertions concerning them are too general, I desire a Specimen of those particulars, which are of such a nature as renders them *incapable* of an Answer.

*A.* I have no need at present to instance in more than one of them, which alone you will think sufficient. ——— I had affirm'd that the Experiment made with the Leyden Phial had discover'd such an opening with regard to Electricity, that it might not improperly be called a Key. A Key, which if properly applied would be found capable of unlocking many of the secrets of nature, or to that effect. But this *serious* Expression was turn'd into so great a jest as not easily to be equall'd. In the first place, they represent me, as endeavouring to shew, that Professor *Muschenbroek* was only the Organ or Instrument employ'd by Heaven (unknown to himself) to deliver the Leyden Phial with the Key

Key annex'd to it into my hands. —

“Then,” say they, “let us see, how he employs this same Key on the Leyden Phial itself: — Heaven grant he be not a Bungler.” —

“Chap. XI. and XII. Nothing done! —

“Mr. Lovett’s is not the true super-celestial Key, but a counterfeit, forged at Worcester. —

“We have attended on him this half hour, fumbling and endeavouring to turn it this

“way and that way to no purpose. The Leyden Phial is just where it was, and as close

“lock’d up as ever. — But stop — see, he takes up the excellent *passé partout* of Dr.

“Franklin. This will do the business, if he has but the address to use it properly. S’death,

“he turns it the wrong way, &c.” Review, p. 377.

Is not this a Specimen sufficient to shew that they endeavour to write in such a manner as to be incapable of a serious Answer? —

But were it worth while, I might instance in many others, wherein by means of *Inconsistencies* and *Sophistry* they are render’d as incapable of an Answer, as in the former. I shall instance in one of their harangues, in a former dispute. — “We would not, however,” say they,

“be too severe on a Writer, who confesses his want of literary Accomplishments, and appears to be a well meaning and inge-

“nuous Enquirer, but to oblige him shall con-

“descend to correct some of his Errors in a candid and good natur’d manner. One great mistake

' mistake of which Mr. Lovett is guilty, par-  
 ' ticularly, indeed, concerns ourselves. As we  
 ' infer'd, from his apparent Ignorance of the  
 ' Newtonian Philosophy, that he was not the  
 ' most fit Person to explain the Phenomena of  
 ' Electricity; he supposes therefore, that we are  
 ' also of opinion, that those Phenomena are  
 ' explicable by Newtonian Principles. But this  
 ' does not follow (a). All the Words that may  
 ' be form'd from the several Combinations  
 ' of the Letters in our Alphabet are not intel-  
 ' ligible to us merely from our knowledge of the  
 ' power and use of each of those Letters; and yet  
 ' without a previous acquaintance with the  
 ' Alphabet, Words in general will not be at  
 ' all intelligible. The Principles of Sir *Isaac*  
 ' *Newton* form the Alphabet of Nature's Lan-  
 ' guage (b); and though even the most perfect  
 ' knowledge of them doth not enable us to  
 ' read at once the various Theorems written in  
 ' the Volume of the Universe; yet, without our  
 ' being initiated into physiological mysteries,  
 ' by an acquaintance with those elementary  
 ' Characters, we can hardly proceed one step  
 ' without blundering (c). "

They next proceed in their begging way, and  
 take for granted their Principle of *Attraction*, and  
 that of the *vis inertiae*, in the following Words.

(a) To reconcile this Inconsistency, they are constrain'd  
 to have recourse to their sophistical manner of arguing.

(b) But this is begging the Question, and taking for grant-  
 ed the very thing that they are expected to prove.

(c) This is still begging the Question.

" True



True indeed it is, that from the Principle of universal Attraction, and the mechanical action of inere bodies, we can in no satisfactory manner account, even for the common Cohesion between the parts of solid bodies, or their various and most palpable modes of Resistance. The reality of such a Principle of Attraction, however, and the vis inertiae of bodies is, nevertheless, indisputable; and the laws of mechanism are no less just; so that whoever would proceed in physiological Enquiries with any well grounded hopes of success, must build on Newtonian Principles: for though all Phenomena are not explicable thereby, yet it is to these Principles we must occasionally recur, to know whether natural appearances are justly explained or not (a)."

Review, 1759, page 300.

A. It may be necessary now to inform you, that there is no other effectual way of dealing with these Pretenders to Criticism with success, than by first divesting them of their *Palladium*, i. e. their offensive and defensive weapon, *Ridicule*; for by means of so powerful and universal an auxiliary, they can elude the force of the strongest Arguments, without any kind of trouble, on any subject that appears to them too formidable to be discussed in a fair and candid

(a) Here I might remark as formerly, the great pains they took to shew, if they could, that true Philosophy was to be learn'd from Sir Isaac Newton's Principles, but not to be explain'd by them.

manner. I shall give you an instance or two, which will be abundantly sufficient to confirm my assertion beyond dispute.

My Theory of the Nature and Office of the Sun has been much applauded, not only as it appears highly reasonable, but as it affords Data sufficient to account for even *Gravity* itself, or that centripetal force and tendency of the heavenly bodies towards the *Sun*, which had before been given up as inexplicable, and for that reason too deep for these shallow Reviewers to fathom.

But by their evasive method, they never fail to shift off the trouble of discussing any subject which they do not understand, as will appear from the following Quotation, page 380. —

“ In the fifth Chapter of this Part, our Author,” say they, “ soars into the extramundane space, and assigns to the Sun and fixt Stars the office of dispensing his subtile Fluid under the title of Circulators, — But here we must leave Mr. Lovett to himself. We should only prove a dead weight to him in his ascent. In good truth, we are afraid to follow this philosophical *Icarus* so very high. We are very ready to attend him at the electric wheel, or as far as to the Blacksmith’s Shop, or even to mount up with him as high as a Thunder-cloud; but not one of our Body, dare-devils as he may think us, to whom this desperate service was proposed, could be found daring enough to trust himself under

under Mr. *Lovett's* guidance, up to those giddy heights in the wide expanded Empyreum to which he here beckons us. — Mr. *Lovett* will, we know, pity our weak heads (4): But really the sight of his Plate, representing numerous Suns and Stars darting forth and circulating his æthereal Fluid, gave us all a Vertigo.

One of the greatest Improperities that they charge me with is my propensity to quoting: And so extravagantly fond are they of proclaiming this on all occasions, as even to defeat their own Intentions, by proving the truth of the very thing that they would deny. — A remarkable passage of this kind may be found in their Review, at page 381, where they say, — “Mr. *Lovett* has indeed two propensities which, somewhat unluckily for his fame, very much interfere with each other; a fondness for making Discoveries, and a strong passion for Quoting: The untoward consequence attending these two propensities is, that he generally conveys to us his Discoveries and Observations in the words of preceding Writers.”

*Answer.* Is this claiming the Discoveries as my own? Can any one forbear laughing at the Inconsistencies of these Writers? For can there be any more effectual way of *disclaiming*

(4) Indeed I do heartily pity, as they prophesied I should, their weak heads; though at the same time, I publickly and sincerely detest their perfidious hearts.



them, than to convey such Discoveries to others in the words of the Discoverers themselves (a).

They also charge me with Quoting from my own self; but who else can I quote from, since no one besides me has treated the same subject in the same way?

Is such disingenuity consistent with that candour and veracity which the Public have an undoubted right to expect from *Persons* who presume to place *themselves* on the bench of literary justice, and arbitrarily dictate to the world a definitive judgement upon so curious a subject, which they have only superficially consider'd (b): Whereas the Author hath made the same subject the particular object of his study at his leisure hours for a great part of his Life.

That Men of their pretended rank should so risk their Reputation to serve no other purpose

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(a) To say the truth I have two cogent reasons to urge in defence of my quoting; first, I seldom could think so well of my own method or stile of Writing, as of that of most other Authors; and, secondly, for the same reason it was my common method to publish the Discoveries and Observations of others in their own words.

(b) That this is notorious, see their Animadversions on my Reviewers review'd, or the conclusion of my printed Letter to them. — Their own words are the following.

*"We shall leave the Illustration of this intricate Subject, to such as may make it the particular object of their Study."* —

Here the Inconsistency of those celebrated Writers is highly worthy of remark, who, though they tacitly confess that they have not made Electricity a principal object of their Study, should yet, at the same time, take upon them to correct those who have. This is modesty indeed, and shews their polite taste for Criticism!

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than the mere gratifying of an implacable temper! It could hardly have been credited, that ever the Authors of the Monthly Review would have acted so mean a part to serve so base an end, had it not been plainly and undeniably prov'd against them.

They next publicly arraign me as being ridiculously vain-glorious, and laying claim to most of the Discoveries that have been made in Electricity, or at least to those that are mentioned in the Essays: Whereas the Reader will find the reverse of that Character to be due to me. I have been always exceedingly cautious and careful when writing, that nothing dropped from my Pen which could be construed like claiming any Discovery; particularly, those to which I had no right.

As those implacable Writers, those false accusers, have taken great pains to render me a most ridiculous and vain-glorious Author, one who endeavour'd to impose on the Public by gross misrepresentations, false pretensions, and down-right Lyes; 'tis presumed I ought in justice to the world as well as to myself, to say somewhat in defence of my own Character, and to shew that I might with truth have laid claim to many Discoveries, though I did not:

As,—First, I might have affirm'd that I was the only one among either the Moderns or the Antients (besides Theophrastus) who discover'd and maintained that Fire and Heat were two different and distinct things. That the former

was

was the Principle or *Cause*, and the latter was only an accidental Property of it. An Effect, generated by a mutual attrition of the Particles of Fire among themselves. — Secondly, I might with equal truth have affirmed, that I was the first Discoverer of a variety of other things, as — That I was the first who had observ'd, that the electrical Fluid was the true elementary and most pure Fire, equal in purity to that of the solar Fire in the focus of a burning glass, insomuch as like that, to yield neither smoke nor ashes. — Thirdly, That I was the only Person who had explain'd the convulsive Experiment, that is, the effect produced at the discharging of the Leyden Phial; or that ever attempted to explain it from Principles previously prov'd. See Chap. XII. of the first Part of my Essays, or the VIII Dialogue of the present Performance. — Fourthly, That I had discover'd a rational method to account for many electrical Experiments in a more satisfactory manner than was known before, particularly, the detension of the electrical Fluid in the open Air, when accumulated on bodies electrified, notwithstanding its extreme elasticity and surprising expansive force. — Fifthly, That no one besides me ever discover'd the great necessity of considering the indefinite elasticity and rarity of the subtile Medium, according to Sir Isaac Newton's investigation, and of its existence in the pores and vacuities of all gross bodies; a clear knowledge of which is absolutely



solutely necessary, that without it, as I have  
 more than once before observ'd, it would be  
 impossible to account for any of the electrical  
 Experiments so as to reconcile them with ob-  
 servation, let with one another: Of this I am  
 so very certain from a strict and repeated exa-  
 mination of the premises, that I can venture  
 to affirm, that the Experiments are absolutely  
 inexplicable by any other means. — Sixthly,  
 That I had discover'd the common mistakes  
 concerning Magnets, that of their being possess-  
 ed, like the Earth, of two Poles and an Axis.  
 That I had detected the mistake, by observing,  
 if that were the case, that a large one might  
 be divided and subdivided, and yet each part  
 would be endued with two Poles and an Axis,  
 as well as the whole before it was divided. —  
 Seventhly, I might moreover have boasted,  
 that the Authors of the *Critical Review* had  
 declared it their opinion, that I had discover'd  
 the very Laws by which the Variation of the  
 Mariner's Compass-needle is influenced. —  
 Eighthly, And though the Monthly Reviewers  
 affirm'd that they did not discern any one good  
 purpose in the *World* that could be serv'd by  
 my *Essays*, yet the Authors of the *Critical*  
*Review* discover'd so much in them that was  
 useful and valuable, that they thought fit to  
 recommend the perusal of them, as being evi-  
 dently a *Work of Genius*, and by no means un-  
 deserving the perusal of modern Philosophers. —  
 Ninthly, In a word, had I been so fond of  
 claim-

claiming Discoveries, as I am represented to be, I should doubtless have set up a Title to a variety of other grand Discoveries, even a rational method to account for the Cause of Gravity itself, as well as Cohesion, the origin of Motion, &c. &c. since those formidable difficulties were never surmounted before in a natural way.

The particular Discovery which they next charge me with claiming is that of the permanency of Fire; and as they seem justly enough to think that some proof would be expected, they are accordingly, at page 379 of their Review for 1768, found drawing up their Charge in the following manner.

“ Our Author proceeds in his Second Part to treat of Fire, which he considers as an element, or as he chooses to express it, a created Entity, which, says he, elsewhere, I have discover’d to be permanent.”

*Answer.* This last Assertion (viz. *I have discover’d to be permanent*) is absolutely false, and I defy them all to point out one single passage in any part of my Essays, where I affirm’d, that I had discover’d Fire to be permanent.

These Words are no where to be found, but in a *supposed* Declaration, which I imagined likely enough to have been made by Bishop Berkeley placed in that philosophical situation, which you will find particularly described a few pages on.

Indeed,

“ Indeed, so universal a Principle, as Fire appears to be, could not fail of exhibiting at all times its extensive properties, and therefore, happily long ago, some Men pursued their enquiries into the essence of it, from its remote effects. This appears to have been the case with respect to many of the Antients, who, without the advantage of our modern Experiments on Fire, have given us a most accurate account of it; an account which corresponds and coincides with the Fire which we have discover’d by means of Electricity to a most surprising exactness, as any one will see, when he compares their description of it with our discoveries.”

The learned Bishop of Cloyne judiciously adopted their opinions, and collected many of them in his *SIRIS*, where he has also given us his own Sentiments on the subject.

The following is a Transcript of Bishop Berkeley’s Theory of Fire, which it will be necessary to insert here to elucidate the present subject.

“ The order and course of things, and the Experiments we daily make,” says that learned Prelate, “ shews there is a Mind that governs and actuates this mundane System, as the proper real Agent and Cause. And that the inferior instrumental Cause is pure Æther, Fire, or the *Substance of Light*; which is applied and determined by an infinite Mind in the Macrocosm or Universe, with unlimit-



ed power, and according to stated Rules;  
as it is in the Microcosm, with limited power  
and skill by the human Mind." *Sicis* Sect.

154.

"The Calidum innatum, the vital Flame,  
or animal Spirit in Man, is the supposed cause  
of all motions in the several parts of his  
Body, whether voluntary or natural; that is,  
it is the instrument by means whereof the  
Mind exerts and manifests herself in the mo-  
tions of the Body, &c." *sect.* 156.

"This pure Spirit or invisible Fire is ever  
ready to exert and shew itself in its effects;  
cherishing, heating, fermenting, dissolving,  
shining and operating in various manners;  
where a subject offers, to employ or deter-  
mine its force. It is present in all parts of the  
Earth and Firmament, though perhaps latent  
and unobserv'd, till some accident produceth  
it into act, and renders it visible in its effects."  
*sect.* 157.

"There is no effect in nature, great, mar-  
vellous, or terrible, but proceeds from Fire;  
that diffused an active Principle, which at  
the same time that it shakes the Earth and  
Heavens, will enter, divide, and dissolve the  
smallest, closest, and most compact Bodies.  
In remote cavities of the Earth it remains  
quiet, till perhaps an accidental spark from  
the collision of one stone against another,  
kindles an exhalation, that gives birth to an  
Earthquake, or Tempest, which splits Moun-

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tain or overturn Cities. This same Fire stands unseen in the focus of a burning glass, 'till subjects for it to act upon come in its way, when it is found to melt, calcine, or vitrify the hardest bodies." sect. 158.

No Eye could ever hitherto discern, and no Sense perceive the animal Spirit in a human Body, otherwise than from its effects. The same may be said of pure Fire, or the Spirit of the Universe, which is perceived only by means of some other bodies on which it operates, or with which it is join'd." sect. 159.

In the human Body, the Mind orders and moves the Limbs: But the animal Spirit is supposed the immediate physical cause of their motion. So likewise in the mundane System, a Mind presides, but the immediate, mechanical, or instrumental Cause, that moves, or animates all its parts, is the pure elementary Fire or Spirit of the World. The more fine and subtile Part or Spirit is supposed to receive the impressions from the first Mover, and communicate them to the grosser sensible Parts of this World." sect. 161.

The abrasions of all terrestrial things being render'd volatile and elastic by Fire, and at the same time lessening the volatility and expansive force of the Fire, whose particles they attract and adhere to, there is produced a new Fluid more volatile than Water and Earth, and more fix'd than Fire. Therefore

the Virtues and Operations imputed to Air, must be ultimately attributed to Fire, as that which imparts activity to Air itself (a)."

"The Platonists and Pythagoreans held fire to be the immediate natural Agent, or animal Spirit, to cherish, to warm, to heat, to enlighten, to vegetate, to produce the digestions, circulations, secretions, and organical motions in all living Bodies, vegetable, or animal, being effects of that element, which as it actuates the Macrocosm, so it animates the Microcosm." sect. 166.

"Æther, by the antient Philosophers, was used to signify promiscuously, sometimes Fire and sometimes Air. For they distinguished two sorts of Air. *Plato*, in the *Timæus*, speaking of Air, saith, there are two kinds, the one more fine and subtle, called Æther, the other more gross and replete with Vapours. This Æther or pure Medium seems to have been the Air or Principle from which all things, according to *Anaximenes*, deriv'd their birth, and into which they were back again resolv'd at their Death. *Hippocrates*, in his *Treatise de diæta*, speaketh of a fire, pure and invisible; and this according to him, is that, which stirring and giving movement to all things, causes them to appear, or as he styles it, come into evidence, that is, to exist every one in its time, and according to its destiny." sect. 168.

(a) See my 4th Fundamental Principle, *Essays*, p. 223.

This



This pure Fire, Ether, or Substance of Light was accounted in itself invifible and "imperceptible to all our Senses, being perceiv'd only by its effects." sect. 169.

"Such is the rarifying and expansive force of this element, as to produce in an instant of time the greatest and moft stupendous effects; a fufficient proof not only of the power of fire, but alfo of the wifdom with which it is managed and withheld from burfting forth every moment to the utter ravage and deftruction of all things. And it is very remarkable, that this fame element, fo fierce and deftructive, fhould yet be fo variously temper'd and applied, as to be withal the falutary warmth, the genial, cherifhing, and vital Flame of all living Creatures." sect. 170.

"Thus *Hypocrates*, in his Treatife, *de diæta*, fpeaks of a ftrong but invifible Fire that rules all things without noife. Herein, faith he, refides Soul, Understanding, Prudence, Growth, Motion, Diminution, Change, Sleep and Waking. This is what governs all things, and is never in repofe." sect. 174.

"*Theophrastus*, in his Book, *de igne*, diftinguifheth between Fire and Heat. The firft he confiders as a principle or caufe, not that which appeareth to Senfe, as a paffion or accident, exifting in a fubject, and which is in truth, the effect of that unfeen Principle. And it is remarkable, that he refers the treat-

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ing of this invisible Fire or Heat to the investigation of the first Causes, Fire, the principal, is neither generated nor destroyed, is every where and always present: while its effects, in different times and places, shew themselves more or less, and are very various, soft and cherishing, or violent and destructive, terrible or agreeable, conveying Good and Evil, Growth and Decay, Life and Death, throughout the mundane System." sect. 176.

"In the *Asclepian* Dialogue we find this notion, that all parts of the World vegetate by a fine subtile Aether, which acts as an Engine or Instrument, subject to the Will of the supreme God." sect. 177.

"The Light, Fire, or celestial Aether, being parted by refracting, or reflecting Bodies, produceth a variety of colours; even so, that same apparently uniform substance being parted and secreted by the attracting and repelling powers of the divers secretory ducts of Plants and Animals, that is, by natural Chemistry, produceth or imparteth the various specific Properties of natural Bodies. Whence the tastes and odours, and medicinal Virtues so various in Vegetables."

Much more to the same effect is contained in his *Six* to strengthen and confirm the doctrine of an universal Aether or Fire: But it is presumed, that what I have transcribed is amply sufficient for a Specimen. Those, therefore, who are conversant with that Theory, may

may easily turn over such of the Sections which may be thought superfluous; while others, perhaps, who never saw any of them, will not be offended at their number.

When I consider'd how minutely Bishop Berkeley's Theory of elementary Fire agreed with what we have since discover'd and reduced to practice, I could not help reasoning with myself in the following manner.

[Had it been the Bishop's Lot, instead of Professor Muschenbroek's, to have discover'd the famous Experiment with the Phial, since call'd, the Leyden Experiment. Had he been thoroughly acquainted with the subsequent Improvements which have been made in Electricity, and had conceal'd the Discovery of them till he publish'd his *Siris*; instead of the form in which it now appears, he would probably have concluded it after the following, or a similar manner.]

I am thoroughly convinced that had I published this account of *Ether* or *Fire*, unsupported by Experiments, it would have been rejected as romantic; but I can with the greatest Pleasure and Truth inform my Readers, that I have happily discover'd the very ethereal Medium, which I have here been treating of, and by means of a simple Machine and very little Labour am enabled to produce it; not from the Air encompassing the Machine, as might be supposed, but from the Earth, Water, Minerals, Animals, Vegetables, &c. And what will seem much more strange,



I can not only demonstrate it to be Fire, but can collect the same Fire from the Thunder-clouds (a) in great abundance; and retain it even in such plenty, as when let loose, to produce loud claps of Thunder (b); and what will undeniably prove it to be the very identical Fire, which I collect at my Machine, I can make the very same Experiments with it; so that I am thoroughly convinced, that this wonderful Agent must be universal, and that all Nature is replete with it. And notwithstanding the extreme elasticity and subtilty with which it is endued, I can collect and retain it, in almost whatever quantity I please, whereby all its most essential and accidental Properties may be easily discover'd by proper Experiments.

In a word, this is the universal subtle Ether so much like Air, which according to Sir Isaac Newton is expanded throughout all the Heavens (c), and the same which he affirms to lie hidden in the pores of all gross bodies (d); and this Ether is therefore the pure elementary Fire of the Antients, which I have discover'd to be permanent.

[Had the Substance of what is contain'd in the foregoing Sheets been introduced, with all the additions and graces with which so accomplish'd a Writer was capable of adorning the

(a) Dr. Franklin's Experiments.

(b) See Romas's Kite, Sect. 313, 314, Part I. of the Essays.

(c) Optics, Quære 18th.

(d) Principia, lib. III. Page 393.

Subject; what a different effect would it have had on the Minds of Men, who were all, till then, ignorant of the Existence of any such active mechanical Agent in Nature? What a general Reception would his Book have met with? Who, after that, would have doubted, whether the electrical Fluid, just then discovered, (which was endued with the same qualities that Sir *Isaac Newton* had ascribed to his æthereal Fluid,) was the same Fluid or not, particularly, as it must have appear'd to be actual Fire, insomuch as not only to kindle up combustibles into a real flame, but to fuse metals in an instant (a)?]

Thus have I, exclusive of my own trouble, given the Reader that of this recapitulation of that feign'd Speech, which I supposed might without any impropriety have been made by Bishop *Berkeley* at the conclusion of his Theory on Fire, which, it was presum'd, I might do without giving offence to any Reader; but it seems that these Scandal-hunters, having search'd my whole Book, could find no passage in it so proper to fix on, as a basis whereon to found their Assertion, as the six last words of that feigned Speech, viz. "*I have discover'd so be permanent.*" No one, however, thinks them so stupid, or so short sighted, as not to see the plain drift of that expression; and their ushering it in with an *elsewhere*, was a proof sufficient to shew a conscious guilt of some-

(a) As in Dr Franklin's Experiments.

thing couch'd under it, which they were endeavouring to conceal.

May I not now justly appeal to the Public, whether such a false and scandalous way of proceeding be not playing a mean and low game, since they could have no other reason for it than merely to gratify an implacable and persecuting Temper (a); such a reason as any honest Author would be ashamed of?

Can such Men be deem'd *Promoters* of Science, who thus labour to suppress so interesting an enquiry as that into the Nature and Uses of that grand mechanical Agent, which is just now *discover'd* by means of the electrical Apparatus? Was not my Assertion just, when I affirm'd that they had arrogantly usurped a Title and Office which they were unqualified for?

How contemptible must such a Conduct render them, whilst they thus basely prevaricate even when pretending to relate a plain matter of fact? May they not justly expect to share the same fate with the Shepherd's *lying* Boy in the Fable, who, in sport cried out, the Wolf! the Wolf! for if they are not to be believ'd when they are relating facts, their veracity may well, *like his*, be suspected at other times.

Such vile proceedings are more than sufficient to tempt us to suspect that many things which they are accused of by common fame

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(a) Could they think of thus imposing on me, without imposing on the Public at the same time?



are true, which are otherwise too atrocious to be credited, and which common humanity would forbid us to credit where Men are not remarkably abandon'd.——What can be more wicked than thus studiously to bear false witness against their Neighbour, as they have done in the present case?

Common Fame chargeth them with receiving a bribe, in order to deal deceitfully with the *World*.——Common Fame affirms that a certain Author wrote a Character of his own Book, and either brought or sent it them, gild-ed with a piece of Gold, which so far prevail'd, that the Author's own Character of his own work appear'd in their Review in the front of their pretended Character. This account I heard of so long ago as our former dispute, before my printed Letter to them in 1761 was publish'd, but could not help thinking it look'd too much like downright Calumny to be credited: Indeed I then really thought they could not be guilty of such very dirty work, but my late experience of the malevolence of their hearts makes me fear, at least, that they were capable even of such an ignominious action.

To the many other Articles which constitute their true Character, that of Ingratitude might be justly added; of which the following is a remarkable instance.

In their Review for March 1773, page 235, they are found displaying their Talents on

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*Marmaduke Berdoe, M. D.* concerning his Doubts relating to the Inversion of Objects at the Retina of the Eye, which they introduce with a Distich, borrow'd from *Pope's Satires*:

"Shut, shut the door, good John! fatigu'd I said,  
Tye up the Knocker,—say, I'm sick, I'm dead."

"Alas! *Pope*," say they, "in his easy Chair,  
and a stout Porter at his Gate, might say all  
this, but we poor Reviewers are not in a  
Situation to give ourselves those airs."

*N. B.* The next Lines exhibit an artful contrivance to bring in the Public *Debtor* to them. "In an *evil* hour—it is now—let us  
' see — three and twenty years ago — we  
' voluntarily undertook to receive all comers  
' of whatever quality from the press, and to  
' give an account to the Public of their business (a)."

"With respect to our present Visitant (b);  
' thrice already have we civilly, — much too  
' civilly — out of mere good nature shewn  
' him the door, and we were in hopes that he  
' would have taken the hint. On the present  
' intrusion however, matters are now come to a  
' crisis between us, and we find ourselves under  
' a necessity for our own Credit's sake, absolutely  
' to turn him out by head and shoulders (c)."

(a) In an *evil* hour — Here, instead of gratefully acknowledging the favours for which they stand deeply indebted to the Public, they begin their Harangue with an ungrateful Insult upon their Benefactors.

(b) The Doctor.

(c) Could such rustic Language become any Critics besides such polite ones as themselves?

The above Transcript of their Remarks on Dr. Berdon, being a curious Specimen of their *boasted Civility* to him, induced me to present my Readers with it in this place.

I cannot take leave of the Monthly Reviewers without observing to the Public as well as to themselves the remarkable difference of Sentiments between them and those of the Authors of the Critical Review; the former shewing no manner of regard to the Importance of the Subject, whereas the latter point it out as highly worthy of the pursuit of the Learned. Since they, far from ridiculing or contemning my feeble Pen, conferred a respectful tribute of their praise upon my Performance, and warmly recommended it as worthy the perusal and attention of modern Philosophers; and where they object to any thing that I have advanced, they do it with that Candour and Impartiality which will always mark a wide distinction between the fair and judicious Critic, and the illiberal and incompetent Caviller.

To set this affair in a proper light, I think it incumbent upon me to recite the Remarks of the Authors of the latter upon the subject at length, and to endeavour to satisfy them in the course of the recital in those few Articles in which their Opinion differ'd from mine.

Critical Review, page 281. "*It were unnecessary to dwell on the first part of this performance, as it consists chiefly of a Recapitulation and Confirmation of the Author's Opinions*" con-



( 185 )  
 ' contained in his former Publications: viz.  
 ' that the electrical Fluid is absolutely and posi-  
 ' tively the same with Sir Isaac Newton's  
 ' Æther. Besides, the subject is out of date,"  
 (with submission, it is impossible for the subject  
 ever to be out of date, since Fire is provided to  
 be a permanent Principle,) "and therefore we  
 ' shall pass on to Part the second."

" Having in the first Part demonstrated the  
 ' electrical Fluid to be Æther, he now proceeds  
 ' to prove that Æther is the true elementary  
 ' Fire, which he thus defines,"

" 1. Fire is an element in the strictest sense of the  
 ' word, and consequently a permanent Principle.

" 2. It is in form of an exceedingly fine Air  
 ' or Æther, and is by means of Electricity disco-  
 ' ver'd to exist in the pores of all gross bodies."

" 3. True Fire subsists without a Pabulum;  
 ' and consequently yields neither smoke, ashes, or  
 ' any other gross feculent matter."

" 4. True Fire is either hot or cold, according  
 ' to the temperature of the body in which it exists.  
 ' Heat, according to our Author, is an acci-  
 ' dental property of Fire, generated by the mutual  
 ' attrition of the particles of Fire. — That  
 ' heat is not an essential property of Fire, he  
 ' proves from electrical Experiments, particularly  
 ' those of Dr. Franklin, who melted Pins, Need-  
 ' dles, Gold and Glass, without the least percep-  
 ' tible warmth in the melted bodies; and as a  
 ' farther proof of his assertion alledges, that,  
 ' except Metals, nothing affords so great plenty

of electrical Fire as Water.

In considering Fire as a permanent Principle, though our Author differs from the generality of Philosophers, who believe it to be nothing more than common matter in violent agitation, yet he is not singular in his Opinion; for such was evidently the Sentiment of the indefatigable Boerhaave, as we learn from his elements of Chymistry. Such was also the Opinion of the learned and ingenious Bishop Berkeley; and such was the doctrine of many of the antient Philosophers."

Answer. What you affirm is most certain, but indeed I had never presumed to differ in Opinion from the generality of Philosophers, relating to a subject so abstruse and difficult as that of Fire was always allow'd to be, had it not been for such a remarkable and most resplendent beam of light that was reflected on the subject by electrical Experiments. — By means of which light, we are now so happy as to see realiz'd, what former Philosophers only conjectur'd, and who, consequently could reason on it but very imperfectly. — What they could judge of from some of its remote effects only, is completely demonstrated to us by means of the plainest facts.

Critical Review. "In a note on a passage which our Author quotes from Bishop Berkeley in proof of his own Opinion, he says, almost every breath we respire informs us that there is something contained in Air, which is absolutely

‘lutely necessary to Life; this is verified if the  
 ‘Bed-clothes are but wrapped and confin’d closely  
 ‘about the head, so that no fresh Air may have  
 ‘room to pass; for how soon after are we sensi-  
 ‘ble of a pain in the chest? which increases in  
 ‘proportion to the number of times the Air has  
 ‘been breathed.”

“We allow the fact, but must reject it as a  
 ‘proof of his doctrine, for from the known con-  
 ‘struction of the Lungs, admitting the Air to  
 ‘contain that elementary Fire necessary to Life,  
 ‘there is no reason to suppose that it enters the  
 ‘Body through that organ rather than through  
 ‘the pores of the Skin. Besides there is a much  
 ‘more rational method of accounting for this  
 ‘Phenomenon, by considering the Air as a men-  
 ‘struum for vapors of various kinds. The same  
 ‘Air becomes unfit for frequent respiration,  
 ‘because it is soon saturated, and consequently  
 ‘render’d incapable of absorbing and carrying  
 ‘off those noxious exhalations from the Lungs,  
 ‘which being retain’d and accumulated, prove  
 ‘the cause of suffocation.”

*Answer.* Since the fact is allow’d, what I  
 have advanc’d is no way refuted or set aside,  
 the fact itself being all I endeavour’d to prove,  
 i. e. that there appears somewhat in Air so  
 absolutely necessary to Life, that if we are  
 deprived of it, we very soon expire.

*Critical Review.* “Passing over matters of  
 ‘less import we shall now proceed to Chap. 5.  
 ‘Sect. 121, which contains the Author’s Theory  
 ‘ of



of the Office of the Sun: Comparing the  
 Macrocosm, or great World, with the human  
 Body, the Microcosm, or World in miniature,  
 and thence reasoning from analogy, he supposes  
 the Sun to be the cor mundi or primum Mobile,  
 which circulates thro' the solar System that  
 Ether, Fire, or electrical Fluid which gives  
 Life, Motion, &c. to this part of the Universe.  
 But by what means is this circulation perform-  
 ed? This question we shall answer in the Au-  
 thor's own words. But in order to compre-  
 hend him perfectly, it will be necessary to quote  
 a passage from Sir Isaac Newton's Optics,  
 inserted by our Author, and upon which his  
 Hypothesis is founded. Every body, says Sir  
 Isaac, endeavours to go from the denser part  
 of the Medium towards the rarer, and if this  
 Medium be rarer within the Sun's Body than  
 at his Surface, and rarer there than at the  
 hundredth part of an Inch from its Body, and  
 rarer there than at the fiftieth part of an  
 Inch, and rarer there than at the Orb of Sa-  
 turn, I see no reason why the increase of den-  
 sity should stop any where, and not rather be  
 continued through all distances from the Sun to  
 Saturn and beyond. And though this increase  
 of density may, at great distances, be exceedingly  
 slow, yet if the elastic force of this Medium be  
 exceedingly great, it may suffice to impel bodies  
 from the denser parts of this Medium towards the  
 rarer, with all that power which we call Gra-  
 vity. And that the elastic force of this Medium

is extremely great, may be gather'd from the swiftness of its vibrations.

" Thus far, says our Author, Sir Isaac's Opinion seems to coincide exactly with the present plan. Since then it seems reasonable to suppose that the farther the solar Rays proceed from him, the more dense they are; consequently when they have gone on so far as to meet with those from the nearest Systems around them, they must in those far distant regions be densest of all. Is it not then natural to conclude, that at so dense a part of so extremely elastic a Medium, it must from thence return again to the most rare part from whence it was sent, and in its progress cause the centripetal force of the Planets, i. e. that force which causes them to gravitate towards the Sun."

" Doubtless there is some Ingenuity in this Hypothesis, but it does not by any means follow from Sir Isaac's words above quoted. — That great Philosopher says no more than that bodies floating in a Medium of different density, will tend to the rarest part of that Medium, it does not therefore follow that the Medium itself must circulate."

Answer. That the Medium itself must circulate, cannot be reasonably doubted, if we only consider, that as the Sun's Rays are every moment emitted from all the parts of his body, so there must necessarily, to maintain an equilibrium, be as perpetual a supply, and consequently that the Medium must therefore necessarily circulate.

Chit.

Crit. Review. "*Sir Isaac never supposed the Subtile Medium and the Rays of the Sun to be one and the same thing.*"

Answer. Sir Isaac Newton was not so happy as to be furnish'd with Experiments as we now are, to prove that Æther and Fire were the same thing; nor was it possible in his time to prove that the electric Fluid was actual Fire, notwithstanding it is now so clearly verified to the Senses; consequently the Sentiments that Sir Isaac Newton had then form'd of it, cannot reasonably be put in competition with the knowledge we now have of it, much less that we should form our Sentiments of it from his: Nor can we have any reason to doubt, whether the electrical Fire and the Rays of the Sun are one and the same thing, since by our Experiments we not only find it to be Fire, but of the same nature with the Rays of the Sun, and equally pure; since like those Rays in the Focus of a Burning-glass it yields neither smoke, ashes, nor other gross matter.

Crit. Review. "*Nor can we possibly conceive what power should influence those Rays, or elastic Particles to return from whence they came, after being propell'd with a force sufficient to drive them beyond the Orb of Saturn.*"

Answer. Sir Isaac Newton, just now quoted, says, if the elastic force of this Medium be exceedingly great, it may suffice to impel bodies from denser parts of this Medium towards the rarer with all that power which we call Gra-



city; and then goes on to prove that by means of the swiftness of its vibrations, the elastic force must necessarily be extending great. Optics, query 21.

Crit. Review. "The fluids in the Microcosm are propell'd through one set of Vessels, and return by another, and consequently do not oppose each others progress, which in the Macrocosm, according to our Author's System, must necessarily happen."

Answer. If the Sun as a Circulator be appointed to propel the Æther to the utmost bounds of the Solar System, it cannot reasonably be doubted but that a proper provision is made, that so there be no obstruction in the circulation of the fluid, and that the mode of the propelled, and that of the returning Medium are so differently circumstanced as not to oppose or obstruct one another in their progress; and as the returning part is evidently in form of a mass, it is as clear that the part propelled is in the form of darts or rays; which being emitted with a celerity equal to that of light from the Sun, is sufficient to penetrate the mass of the returning Æther, without either obstructing, or being itself obstructed. And this may not improbably be one principal reason why the Sun was form'd so vastly large, possibly the more effectually to render it capable of performing such a task as that of milling up, of grinding, as it were, or attenuating the Æther and darting it to such an immense distance

tance and penetrating even the mass of Æther itself: For had not the Sun been designed to serve some very extraordinary purposes, a less body might have been sufficient.

*Crit. Review.* "In Chap. XI. He transcribes from Dr. Hales's *vegetable Statics*, that Author's account of several Experiments relative to fixed Air, and in the following Chapter endeavours to prove, that this Air is no other than the subtil Medium of Sir Isaac Newton; but he seems not sufficiently acquainted with the properties of fixed Air to reason upon this subject."

*Answer.* Nor could I ever meet with any one that was able to defend Dr. Hales's reasoning, viz. to make out and explain what he means by *fix'd Air* so as to render it intelligible and satisfactory. ——— I cannot indeed so much admire that the Dr. himself should seem fond of his own *creature*, as that he should have so many who concur with him in so unnatural a scheme as that of a *transpeciation* of the Elements into each other. ——— In my humble opinion, before it was affirmed that I seem'd not sufficiently acquainted with the properties of fixed Air to reason on the subject, it should first have been shewn wherein my reasoning on it was defective.

But however, I must not omit rendering my most grateful acknowledgements to these judicious Critics, for treating the performance in general, in the candid manner they have  
done

done, but especially for the Character they have given it at the Conclusion of their Remarks, as in the following words.

“ It is well known that many attempts have been made towards reducing the variation of the Needle to some certain rule, but hitherto without effect. The Author before us seems to have discover'd the laws by which this Variation is influenced, and in consequence of that discovery is of opinion that the Longitude at Sea may be found with great accuracy. The principal difficulty arises from the general imperfection of the Mariner's Compass-needles, which are commonly used. His Theory is founded on a supposition that the magnetic Pole, to which the Needle points, makes a regular Revolution round the Pole of the Equator in a certain number of Years. As to his mode of Calculation, it were impossible to make it perfectly intelligible without transcribing the greatest part of his Appendix, and therefore we must refer such of our Readers as are curious in these matters to the Book itself, *which is evidently a Work of Genius, by no means undeserving the perusal of modern Philosophers.*” See the Critical Review for October 1766.

N. B. Since the Authors of the Monthly Review have thus endeavour'd to impose on the Public in so gross a manner as they have done in the present case, 'tis my humble opinion they ought, in justice to it, if they really pretend



pretend to know any thing of Electricity, to consent to what I have formerly endeavour'd to bring them to, viz. that in order to clear up the dispute between us on so curious, so interesting and copious a subject as Electricity is allow'd to be, that they would undertake to dispute the point fairly, *pro* and *con*, by the channel of their monthly Paper, and then, whatever objection they might think proper to make, I would be sure to reply to, and send it them time enough to be inserted in their next. —

A correspondence of this kind was solicited in my public Letter to them, and treated by them with their usual Air of Contempt.

However, were they now to make a reply, the same excuses which they then made, would by no means serve their turn; that part of their dialect is grown too stale to pass current at this Time: That which they advanced 11 Years ago, when I first sent them the same invitation would by no means now serve the turn; — Their reply to that invitation being remarkably arrogant, I shall here repeat it.

“ The design of our Work ” they say, “ is mistaken by such as suppose it the Business of the Reviewers to set every *wrongheaded* Author right; or that they have arrogantly undertaken to supply every thing they may see wanting in the works of others. They think it in general sufficient that they point out the principal defects in the Performances of such mistaken Writers; who would also  
do

( 200 )  
do well, instead of obstinately persisting in  
their errors, and growing impatient at well  
meant reproof to submit with temper, and  
learn to profit by just correction." (a)

See their Answer to my Reviewers review'd  
1761, or my Letter to them in the same Year.  
page. 24.

However, I am well assured that their  
Knowledge of Electricity is too superficial to  
enable them to attempt any thing, either for it,  
or against it by way of controversy; and I chal-  
lenge them and all their adherents to enter into  
a fair and candid *debate* on the Subject, and  
should think it the greatest pleasure to be  
engag'd in so laudable a dispute with Persons  
capable of refuting my Arguments, and thereby  
setting me right where I am wrong. But  
they must not think to *object*, and *object*, and  
produce no proofs to the contrary as usual,  
but Arguments more convincing will be ex-  
pected, and such as are supported with Ex-  
periments equally conclusive.

(a) And by such arrogancy, evasions, and prevarications  
instead of Argument, they shuffle off a sordid and satisfacto-  
ry reply.

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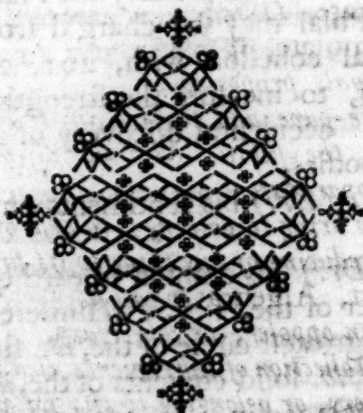
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Glos.





G L O S S A R Y;

O R,

E X P L A N A T I O N

Of the more uncommon Words.

A

**A** BSTRUSE *not easy to be understood, difficult.*

Accelerate, *to hasten, or increase motion.*

Accumulate, *to heap up.*

Adequate, *equal, proportional.*

Æther, *a more pure and perfect air than that of the Atmosphere, the subtile Medium discover'd by the electrical Apparatus.*

Annihilate, *to bring to nothing; to destroy utterly.*

Analize, *the reducing of any thing to its first Principles.*

Analytical Art, Algebra *so call'd.*

Antagonist, *an opposer, or adversary.*

Apparatus, *a collection of instruments used to shew experiments.*

Aquatic, *watery, or belonging to the water.*

Arcanum, *a secret.*

Area, *the superficial content or measure of any thing.*

Argument, *a reason, or proof.*

Atmosphere, *the lower part of the region of the air, with which our earth is surrounded.*

Attraction, *a drawing of one thing to another.*

Attrition, *rubbing, wearing, or fretting.*

Axiom, *a plain, self evident truth, or proposition.*

# G L O S S A R Y.

## C.

- Capsula**, the case or husk of any thing.
- Caviller**, one who pulls down and builds up nothing in its place.
- Celerity**, swiftness.
- Center**, a point equally remote from either of the extremities of a line, figure, or body.
- Centrifugal**, that endeavours to fly or go from the center.
- Centripetal**, whatever compels things towards their center.
- Chaos**, a confus'd jumble of things of different natures.
- Circuit**, any figure that begins and ends at the same point, as a circle, ellipsis, &c.
- Coagulate**, to congeal, curdle, or thicken.
- Coalition**, a growing together of parts in one mass.
- Cohesion**, the action whereby the constituent particles of natural bodies are connected or joined together.
- Collision**, a striking of one thing against another.
- Combustible**, any thing that easily takes fire, as oil, &c.
- Concatenation**, a linking, or tying things together.
- Concentric**, that hath one and the same center.
- Condensify**, the reducing a body into a less compass.
- Condensing Phial**, the collector of the electrical fluid.
- Cone**, a solid body, that has a circle for its basis, and is terminated in a point at the top called the vertex.
- Confectary**, a consequence or deduction.
- Constituent**, an essential part that composes any thing.
- Contraction**, a drawing up or closing together.
- Converging**, an inclining or drawing towards each other.
- Corollary**, a consequence or conclusion drawn or made from some antecedent demonstration.
- Corpuscles**, the smallest part or physical atoms of a body.
- Criterion**, the test or proof of the truth or falsehood of a thing.
- Culinary**, belonging to a kitchen.
- Current Philosophy**, the present establish'd Philosophy.
- Cylinder**, in the form of a garden rolling stone.
- Data**,

# Y G L O S S A R Y.

## D.

**Data**, things known, given or granted in a proposition.

**Dense**, thick, oppos'd to thin.

**Desideratum**, something wanted or sought for.

**Dilatation**, expanding to a greater bulk than common.

## E.

**Effluvia**, small particles of matter that fly off from bodies.

**Egress**, the act of going out.

**Elasticity**, a springiness or power to recover its former place when bent.

**Electrical Fluid**, or Medium, the medium discover'd by the electrical apparatus.

**Electrical Philosophy**, founded on the effects of experiments, or the discoveries made with the electrical apparatus.

**Electricity**, the property that amber, glass, sealing-wax, &c. have when rubbed.

**Electrometer**, an instrument wherewith to ascertain the measure of the force of electricity.

**Electrics per se**, those bodies in which the electrical fluid is fixed.

**Elementary-Fire**, fire so pure, as to yield neither smoke nor ashes.

**Elements**, in natural philosophy, pure and unmix'd; the first principles or ingredients whereof bodies are composed; and are conceiv'd to be simple and homogeneous.

**Epicycle**, a little imaginary circle invented to solve the stations and retrogradations of the planets.

**Equilateral**, a figure whose sides are all equal.

**Essential**, the nature, substance, or being of a thing.

**Expanse**, the firmament or heaven.

## F.

**Feculent**, full of dregs.

**Fermentation**, an intestine motion of the small insensible particles of a mixed body.

**Fluxion**,



## G L O S S A R Y.

- Fluxion, *a flowing or running.*  
 Factitious, *artificial, counterfeit.*  
 Focus, *the point of convergence or concourse where the rays meet and cross the axis after the refraction by the glass, or reflexion by means of a concave mirror.*  
 Force of Gravity, *that quality which causeth bodies to tend to the center of the earth, or to each other.*  
 Fossils, *all bodies that are dug out of the earth.*  
 Friction, *rubbing or chaffing.*  
 Friblers, *captious, impertinent triflers.*

### G.

- Genus, *the stock or general name comprehending the species under it.*  
 Geometry, *the art of mensuration.*  
 Gravity, *weight, &c.*  
 Gravitation, *the pressure or action of an upper body upon another that is beneath it.*

### H

- Heat, *a peculiar quality of fire excited by a mutual attrition of its particles.*  
 Hemisphere, *half of a sphere.*  
 Heterodox, *contrary to receiv'd opinions.*  
 Heterogeneous, *compounded of things of a different nature, kind, or quality.*  
 Homogeneous, *of the same kind, nature and properties.*  
 Horizon, *that great circle of the sphere, which divides the upper hemisphere or half compass of the heavens which we see, from the lower hemisphere that is under us, and bidden from our sight.*  
 Horizontal Parallax, *the difference between the true and apparent horizon.*  
 Horse-laugh, *a noisy roar when argument fails.*  
 Hypothesis, *a supposition.*  
 Hypercritic, *a master critic, or over critical.*

### I.

# G L O S S A R Y.

## I.

- Immaterial, *a body not compos'd of gross matter.*  
 Immerg'd, *dipp'd or plunged into.*  
 Immutable, *unchangeable, fixed, unalterable.*  
 Impel, *driven, or thrust forward.*  
 Impetus, *the degree or force of motion impressed upon one thing by another.*  
 Impregnate, *to imbody, soak, or drink in.*  
 Impulse, *pushing, or driving forwards.*  
 Inanimate, *without life or soul, lifeless, dead.*  
 Inculcate, *to instil, repeat often, or get by little and little into a person's mind or understanding any thing that we would teach or have him remember.*  
 Incurvate, *to bow or bend.*  
 Indefinite, *unbounded, unlimited, unrestrain'd.*  
 Inexplicable, *that cannot be unfolded or explain'd.*  
 Inflammable, *capable of being set on fire.*  
 Inflect, *to bow or bend.*  
 Ingenuous, *free, honest, open, sincere, plain.*  
 Ingreis, *entrance into.*  
 Inherent, *innate.*  
 Insulate, *cut off from all communication with the earth.*  
 Interstices, *the pores of a body.*  
 Intumescence, *swelling, rising, or puffing up.*  
 Investigate, *tracing out, or proceeding step by step.*

## L.

- Latent, *concealed, lying hid.*  
 Laudable, *praise worthy, commendable.*  
 Leyden Experiment, *the electrical experiment first made by Professor Muschenbroek.*

## M.

- Macrocosm, *the great world or whole universe, in contradistinction to the microcosm, or body of man.*  
 Mass, *a heap or lump of any thing.*  
 Material, *any thing composed of matter or substance.*  
 Medium,

## G L O S S A R Y.

- Medium**, that peculiar constitution or frame of any space thro' which bodies move, as the air, water, &c.  
**Meridian**, a great circle passing thro' the poles of the world, and both the zenith and the nadir.  
**Metaphor**, a figure in Rhetoric by which we put a strange and remote word for a proper one.  
**Microcosm**, a little world, i. e. the body of a man, so call'd, as a kind of compendium of the greater.  
**Mundane**, of or belonging to the world.

### N.

- Nadir**, that point of the heavens which is directly under our feet.  
**Nature**, the whole assemblage of created beings, and the orderly and regular succession and generation of one thing out of, or from another.  
**Negative**, a denying, or gainsaying.  
**Negative Electricity**, a mode of the electrical fluid which in particular circumstances appears as if in a state of want.  
**Non-electrics**, those bodies in which the electrical fluid is not fixed, as metals, water, animals, vegetables.  
**Nostrum**, a secret in any art or science known to few.  
**Noxious**, hurtful, mischievous.

### O.

- Oblivion**, forgetfulness.  
**Occult**, dark, bidden, unknown, secret.  
**Ocular**, belonging to the eyes, or sight.  
**Optics**, the science of vision.  
**Orbit**, the line described by any thing that moves round. in astronomy it is the path in which a planet moves.  
**Ore**, metal mix'd with the earth of the mine, unrefin'd.  
**Orthodox**, that is of a true or right opinion or belief.  
**Oscillation**, a swinging up and down, or vibration like the pendulum of a clock.

Par-



# G L O S S A R Y.

## P.

- Parallax horizontal, *the difference between the real and apparent horizon.*
- Perforation, *a boring through.*
- Permeate, *to penetrate into or thro' the pores of anybody.*
- Pervade, *to go through.*
- Phenomena, *appearances of meteors, or any other signs in the air or heavens.*
- Physical, *natural, belonging to natural philosophy.*
- Plane, *any extended flat superficies.*
- Plane of the horizon, *the plane that bounds the sight.*
- Pneuma, *the fine spirit or essence of æther.*
- Pneumatics, *treats of the properties of the air.*
- Poles, *the points upon which the imaginary axis of the world, or any particular globe turns.*
- Posteriori, *a mode of arguing from the effect to the cause.*
- Predominant, *bearing chief sway, or over-ruling.*
- Prime-conductor, *that which conducts the electrical fluid immediately from the excited glass globe.*
- Primum mobile, *the principal or moving cause.*
- Principle, *the first cause of the being or production of any thing, a motive or inducement.*
- Priori, *a mode of arguing from the cause to the effect.*
- Problem, *something proposed to be done, and is usually understood of constructing mathematical figures, and demonstrating the truth and reason of the process used to effect it.*
- Projectile, *thrown or cast with a considerable force,*
- Propell'd, *driven forward, or thrust afar off.*
- Process, *the whole course of any operation or experiment.*
- Pro re nata, *occasionally.*
- Pulsion, *the driving or forcing any thing forward.*

## R.

- Rare, *a very thin medium.*
- Rarefaction, *when a body occupies more space than usual.*

## R

Rarity,

## G L O S S A R Y.

- Rarity** or **Rareness**, the thinness of the air, &c.  
**Realize**, to make, cause, or produce any being or thing.  
**Recede**, to go back or retire, to depart from.  
**Recess**, a retreating, going back, or withdrawing.  
**Reciprocal**, mutual, that is return'd on both sides.  
**Rectilinear**, any figure consisting of right lines.  
**Redintegrate**, to renew or make afresh.  
**Reflection**, the returning back of rays of heat or light, by striking upon a hard body.  
**Refract**, to break back again, to resist.  
**Refraction**, the breaking of the natural course of a ray.  
**Refrigeratory**, a vessel to cool things in.  
**Repel**, to beat or drive back.  
**Replete**, full, filled, replenished.  
**Reprehend**, to reprove, or rebuke.  
**Repulse**, to resist, refuse, oppose, or beat back.  
**Respiration**, breathing; an alternate dilatation and contraction of the thorax, whereby the air is taken in by the wind-pipe, and by and by driven out again.  
**Retina**, a certain expansion of the inner surface of the optic nerve of the eye.  
**Retrogradation**, a going back.  
**Reveries**, mad or idle talk, conceits or fancies.  
**Rotation**, an orderly and regular moving round or succession.  
**Rodomontade**, a vain-glorious bragging or boasting.

### S.

- Sanguine**, being earnest in, and zealous for any thing.  
**Scholium**, a remark or observation made upon a proposition, or consequence drawn from a demonstration.  
**Secretion**, the separation of one fluid from another in the body of animals and vegetables.  
**Segment of a Circle**, a part cut off from it.  
**Segregate**, to separate or put apart.  
**Semi-diameter**, the radius, or half of the diameter.

Semi-

## G L O S S A R Y.

**Semi-metals**, mineral bodies, half metallike, such as antimony, bismuth, &c.

**Solar**, belonging or relating to the Sun.

**Sophism**, a fallacious reason, or one that has only an appearance, and not the reality of truth.

**Sphere**, a Globe or round body, contained under one continued regular surface, from the center whereof to the surface all lines drawn are equal.

**Spheroid**, a solid figure, somewhat representing a sphere but not perfectly round.

**Spiral**, that turns round like a screw.

**Square**, a geometrical figure compos'd of four equal sides.

**Stricture**, strict Remarks.

**Subduple**, any thing that is half of another, as the root is the subduple of the Power of it, or as the Number 2 is the Subduple of 4.

**Sublimation**, the raising of solid and dry bodies by fire.

**Sublunary**, under the Orb of the Moon.

**Subtile**, thin, fine, light, pure, unmix'd, separated from all gross matter.

**Subterfuge**, an excuse, pretence, evasion, shift, &c.

**Subterraneous**, that lies before the surface of the Earth.

**Succinct**, brief, short, comprehended in a few words.

**Sui Generis**, of its own kind.

**System**, a compleat treatise, or body of any art or science.

**Synthesis**, composition, or joining things in a regular manner together.

**Synonymous**, two names which have but one meaning.

**Sexagenary Arithmetic**, that which proceeds by sixties as the division of Circles into 60 degrees, every degree into 60 minutes, every minute into 60 seconds, &c.

### T.

**Tangent**, is a right line drawn without a Circle perpendicular to some Radius or Semi-diameter.

**Tangible**, whatever is the subject of the sense of feeling.



## G L O S S A R Y.

- Tenet, *a doctrine or opinion.*  
 Terraqueous, *belonging to the Earth and Water mixed.*  
 Test, *a proof or trial also a Vessel for refining metals, &c.*  
 Theory, *the contemplation or study of any art or science, without practice.*  
 Thermometer, *an instrument to shew the several degrees of heat and cold.*  
 Thorax *the breast or chest, containing the heart, lungs, &c.*  
 Toise, *a french measure about the length of six Feet.*  
 Torricellian, *the device of the Quicksilver weather Glass, so call'd from the inventor.*  
 Transmutation, *changing or converting one substance or figure into another.*  
 Transpeciation, *the changing of one species into another.*

## U.

- Unctuous, *Oily, fat, greasy, &c.*  
 Undulate, *to flow in waves like water.*  
 Universe, *the whole Creation, the frame or mass of material beings.*  
 Vacuum, *a space divided of all body.*  
 Vapid, *palled, deaden'd or grown flat.*  
 Vapour, *a watery exhalation.*  
 Vegetate, *to grow as Plants.*  
 Vehicle, *a general name for that which serves to carry or bear any thing along, as the Serum is a Vehicle for the red Globules of the blood.*  
 Velocity, *that swiftness by which a body passes a certain space in a certain time.*  
 Versed sine, *that part of the Diameter of a Circle which is comprehended between the sine and the Tangent of an Arch.*  
 Vertex, *the summit or uppermost part of any thing.*  
 Vibration, *a very quick and short motion of the solid parts of bodies.*



